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A Survey of Telecommunications Technologies and Services

By Alan Pearce *

INTRODUCTION

Economics has been defined as the study of the allocation of scarce resources among competing users. Whenever a particular resource or product is scarce several things can, and usually do, happen. The price can go up, thus reducing the number of potential buyers; the resource can be rationed or regulated by the government; technology can develop more efficient uses of the resource; or new technologies can be developed that outdate or overtake the old resource.

These rules of scarcity govern most areas of economic activity. Within our dynamic telecommunications field, spectrum which forms the very base of the industry, has generally been regarded as a scarce and publicly held resource. Because of its presumed scarcity, the Federal Communications Commission has been regulating its use for the past 40 years or so.

One of the chief (some would prefer the sole) responsibilities of the FCC is to organize the spectrum in such a way that it meets the greatest public benefit. Since no charge is made for use of the spectrum—economists refer to this as zero cost—the so-called balancing forces of the marketplace do not operate. Market forces, therefore, are replaced by FCC rules and regulations. Over the years these rules and regulations have become almost as complex as the many diversified telecommunications services that use the airwaves.

Because of the enormous growth of telecommunications services, parts of the spectrum space have become crowded with the result that many believe spectrum space to be a severely limited resource that should be carefully preserved. Critics believe that the FCC should take another look at some of the services that use the airwaves with a view to taking space from some services and allocating it to others that are deemed to be more in the public interest.

Although these arguments should be taken seriously, it should also be pointed out that the spectrum is limited because of the inefficient way it has been used.[1] As long as the spectrum is treated as a zero-cost resource, the arguments before the FCC are bound to follow the tradi-

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[1] Raymond Wilmotte, "Technological Boundaries of Television," Office of Chief Engineer, Federal Communications Commission, Washington, D.C., December 1974.

tional "my use is more in the public interest than your use." Consequently, the FCC has found itself in a perpetual dilemma, having to decide between two or more competing users, when all might contribute to the public good.

What the FCC has generally ignored has been recent technological developments that are helping increase spectrum space or make its use infinitely more efficient. Spectrum has been consistently extended by the opening up of higher and higher frequency bands, and bandwidths for various types of communications have been reduced. But the development of newer and more efficient technology designed to increase spectrum utilization does not guarantee its adoption. The economic and the regulatory hurdles have to be met first, and the FCC has been unable to cope with these twin problems because of status quo thinking and significant industry lobbying design to prevent the development of newer technology and to stifle competition.

As an example, one can cite the problem of noise in the use of the radio spectrum. Noise is the hissing sound heard when the set is tuned to a weak signal. There are two basic alternatives for reducing noise: one is to increase the effective power radiated at the transmitter end of the system, and the other is to use more spectrum space by increasing bandwidth. Since spectrum space costs nothing, the broadcasters find it more economical to argue for more spectrum space and the FCC usually goes along with this argument. Sometimes more spectrum space is essential, but often the zero cost of spectrum space has led the industry to discourage the development of new technologies and changes in the design of our telecommunications system.

The control of permissible bandwidth rests squarely with the FCC, which has been charged by Congress to regulate it. A classical example of FCC regulation concerns the AM and FM broadcast bands. Both AM and FM broadcast voice and music; an FM channel is four to five times as wide as an AM and is generally designed to provide higher quality. The FCC decided to give the broadcasters more "free" bandwidth rather than order them to increase power which is costly.

These problems are finally coming to a head due to a recent explosion in telecommunications technology that is encouraging a new wave of competition, and to a more curious and inquisitive Congress and White House. It should also be added that the FCC itself is beginning to realize that spectrum might have been regulated inefficiently in the past.

If the telecommunications technology that is currently available could be offered to all Americans, those services would include:

Reading and answering your office mail from your home;

Browsing through today's sale items at the drugstore or supermarket and "push buttoning" your orders:

Any movie could be seen on the television set in your living room;

Teleprinters in every patrol car, ambulance, fire engine, taxicab, and delivery truck;

Increased use of electronic editing via telecommunications hookups to a remote computer both in the government and business office, thus reducing paperwork and increasing productivity;

Nationwide teleconferencing networks, with two-way voice, data, facsimile, visual displays and hard copy printout capabilities, available almost anywhere now served by the telephone system;

Inexpensive electronic preparation and delivery of mail and newspapers.

TELECOMMUNICATIONS TECHNOLOGY

Our telephone system lies at the heart of the telecommunications industry. AT&T and The Bell Laboratories are often thought to form the backbone of telecommunications technology, not only in the United States but throughout the world.

In its extent and diversity, the telephone network is perhaps one of the most complex of all human artifacts. It has achieved this status by carefully assembling many individual building block components into a highly interconnected and hierarchical system. The United States has over five times as many telephones as Japan, the next largest telephone system; the mileage of wire in cable would girdle the globe 27 thousand times; and there are also many switchboards to route calls along these wires.[2] The flexibility of interconnection at terminals combines manual, dial, and electronic switchboards; microwave radio relays, coaxial cables, and waveguides to carry the very high density telephone trunkline traffic; and land mobile radio or television network program distribution often couple with the telephone network. The telephone switching hierarchy has evolved to five levels: the end offices connect to subscribers; above these are the toll centers, then the primary, the sectional and the regional centers.[3] Other telecommunications systems such as broadcasting, cable television, computer services, subscriber responses from the home, and two-way television at educational, medical, business, and governmental facilities add to this complexity.

The system is formed from a composite of simpler units; these units are assembled into a rough, hierarchial structure, with numerous simpler functions being performed at lower levels and more sophisticated activities in the upper levels. The hierarchy of telecommunications technologies shown in Table I parallels the historic development of the distribution technologies—earlier ones at the top, with the later, and more sophisticated ones, at the bottom. Conducting pathways, referred to as hardwired channels, should be distinguished from broadcast channels. Terminal facilties that convert human responses to electrical signals, one signal form to another, and signals to humanly understood outputs are too varied to treat in any fashion other than discussing some of their key features—especially those relevant to the expected future developments in telecommunications.

Without the message pathway forming the communication channels for signal distribution, there is no "telecommunications" technology. The first telegraph message between Baltimore and Washington on May 24, 1844, convinced the world that electrical signals carried along conducting pathways could transmit useful information. Since then the capacities of conducting pathways, or hardwired channels, have increased at an average rate of 14% per year.[4] Today's most advanced technologies offer more than 30 million times the capacity of the first telegraph line. These improvements in channel capacity arose from learning how to transmit messages simultaneously—called multiplexing—and how to reduce signal losses enroute.

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[2] There were 143,971,000 phones of all companies listed by the FCC, and 16,443 control offices of the Bell System as of Dec. 31, 1974. Bell telephones numbered 118,148,000 as of Dec. 31, 1974.

[3] James Martin, *Telecommunications and the Computer*, Prentice Hall, 1969, page 321.

[4] See James Martin, *op. cit.*, 169, p. 8.

TABLE I.—TELECOMMUNICATIONS TECHNOLOGIES

Distribution		
Hardwired	Broadcast	Terminal facilities
Local (user facilities):		
Single wires	Radio	On-line channel.
Twisted pairs	Television	Storage.
Coaxial		Mobility.
(Fiber optics)		Computer.
Trunklines (central facilities):		
Large diameter coaxial cable.	Microwave relays	Fixed logic switching.
Waveguides	Satellites	Programable switching.
(Fiber optics)	(Millimeter wave systems)	Computer services. Off-line memory.

Note: Parentheses represent technologies or services that are only in the experimental or conceptual stage of development.

The left-hand column of Table I lists the principal types of distribution using "hardwired" channels. Many of the older, lower capacity technologies are still used for local distribution, but newer technologies have lower costs at the high volume of traffic along trunklines. The progression of successive technologies is characterized by the introduction of a more rapid change of signal level which is the same as carrying higher frequencies. Faster changing signal levels create a greater information carrying capacity by packing more discrete pulses into the channel. A few comments on the principal types of hardwired channels should illustrate these points:

I. Hardwired Distribution

A. *Single wires*, such as early telegraph lines and modern powerlines, can carry telephone frequencies but they pick up noise from their surroundings.

B. *Twisted wire pairs* reduce the pick-up and cut down on signal loss due to antenna like radiation; they can carry up to 24 multiplexed voice channels as in Bell's T1 system or even television signals for short distances.

C. *Coaxial cables* reduce radiation loss by surrounding the central conducting wire with a cylindrical metallic foil shield. Several television channels or thousands of phone calls can be carried by a single coaxial cable.

D. *Large diameter cable* with compressed gas insulation between the central conductor and the shield—rather than plastic foam—reduces the signal power lost to insulator absorption. Such cables can carry television signals 20 or more miles between amplifiers.

E. *Waveguides* go one step further by removing the central conductor and insulation. Transmission is achieved by guiding an essentially radiated signal down the reflective tunnel formed by the shield alone. The recently developed helical waveguides can carry 230,000 simultaneous phone calls.

F. *Fiber optics*, when perfected, promise a 100 to 10,000 fold improvement over today's most advanced operative channels. Fiber optical cables are made up of many long, very pure, glass fibers bound into a bundle. Each fiber presents a perfectly reflecting minute tunnel to transmit visible light. Because of their *potentially* low cost and high capacity, fiber optics will offer a wide range of applications. Currently, however, the cost of pure fiber needed in telecommunications is still prohibitive. In addition, light beams can not be effectively amplified; amplification is carried out by connecting to microwave frequencies. This may be the economically limiting factor for the bandwidth that can be carried.

II. Broadcast Distribution

While hardwired systems struggled to prevent losses due to radiation, the broadcasting industry, started by Marconi in the late 1890's, attempted to use radiated signals as a means of communication. The fundamental unit of measurement of the radiated spectrum, corresponding to a frequency of one cycle per second, was named in honor of Heinrich Rudolph Hertz (1857–1894), who first proved that the vacuum, and the near vacuum of the atmosphere, could transmit radiant electromagnetic energy.

Today's broadcast spectrum begins at about 300,000 Hertz or 300 KHz.[5] Below this frequency efficient radiation of signal power increases radically in cost; above 10 billion Hz, or 10 GHZ, the air itself begins to absorb the signal power. Ultimately the capacity of the broadcast spectrum is finite, but with more efficient encoding of signals, careful control of noise and interference between different signals, protection of the local environment from very intense electric fields near the broadcasting antennas, and a judicious subdivision of each area into local communications zones, many more signals could be exchanged thus making the spectrum less scarce. Below 30 million Hz, 30 MHz, the ionospheric layer of the upper atmosphere reflects radio waves; thus the earth and the ionosphere form a giant reflective wave guide along which radio beams can skip around the world.

The obvious importance of this phenomenon to ocean navigation and international communication need not be explained. For applications of limited geographical scope, however, this property raises interference problems, especially for the less expensive equipment usable at lower frequencies.

A. *Radio* broadcasting, shown in *Table I*, includes all of the transmissions that can skip off the ionosphere. Signal powers are regulated by international as well as national agreements.

B. *Television* uses frequencies above 58 MHz which can provide only a local service since these signals penetrate the ionosphere and are lost in space. For this reason, and because television signals do not fill in shadowed areas very well, almost a direct line of sight between sender and receiver is required for good to excellent reception. Television frequencies are too low to be conveniently focused into narrow beams so they are used to provide wide area coverage to a limited geographic region. Television pictures are transmitted according to a standard wave form established in the early 1950's. Much better picture quality is technically feasible, but this would require alterations to an enormous number of transmitters and receivers.[6] Standardization is difficult—if not impossible—to change, given the current regulatory framework.

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[5] The notation is interpreted as follows: "Thirty Kilo-Hertz", written 30 KHz; "Ten Giga-Hertz", written 10 GHz; "Thirty Mega-Hertz", written 30 MHz.

[6] Raymond Wilmotte, *Technological Boundaries of Television.*

C. *Microwave* frequencies are at the very upper limit of the usable broadcast spectrum. At these frequencies, microwaves can be formed into narrow beams of dish-shaped antennas or horns. These beams are ideal for constructing efficient, high-capacity relays. Hops between relay stations depend upon topography but range between 25 to 150 miles. Many applications of microwave relays are not generally known but are nonetheless very important: telephone long distance trunklines outside urban areas are mostly microwave beams; television network broadcasts are distributed via microwave relays; the Advanced Research Projects Agency of D.O.D. links a nationwide grid of advanced computers into a single microwave relay loop; recent applications involve urban multipoint distribution services (MDS) providing entertainment, such as first run movies and boxing matches, to subscribers via a network of encoded microwave beams.

D. *Satellites* at an altitude of 22,300 miles revolve at the same rate as the earth so they appear to remain fixed in the sky. From this vantage point they can act as signal relays since each views roughly a third of the earth. Satellites also use microwave frequencies, but the transmission path is flexible unlike all other earth bound facilities. Thus they can provide either an emergency replacement for troubled trunklines, such as a damaged submarine cable, or a link to a specialized high capacity user in remote areas not along the fixed trunkline pathways.

E. *Millimeter wave systems* and laser systems attempt to use the high frequency intermittent atmospheric windows of greater information capacity, or "band-width," to construct a very high information capacity link. Many of these applications will be limited to urban, sheltered, or desert environments because "windows" are affected by fog, rain, and snow.

III. Terminal Facilities

All telecommunications channels require signal conversion to a humanly understandable form. Similarly, they require signal power, amplification and noise suppression. High capacity channels, such as the radio and television broadcasting spectrum, are subdivided into bands or narrow channels, by "multiplexing" techniques. The frequency band structure of the radio and television spectrum is referred to as frequency division multiplexing. Alternative schemes for breaking up and compressing messages are time division multiplexing, delta modulation, pulse code modulation, digital format encoding, etc. Each is intended to squeeze more messages into a finite capacity channel an dto reduce signal distortion or transmission errors. These methods need not be discussed further since the relatively higher costs of sophisticated coding at the terminals is generally traded-off against the higher costs of implementing higher capacity channels. The receiver costs of the telephones, radios and television sets are kept low by using relatively simple codes, while the submarine cables, satellite transmissions, and microwave computer networks use relatively complex and more expensive codes.

The features selected as important for the purposes of this paper are the new or emergent user options and the central facility options offering greater flexibility of service.

A discussion of the central facility options shown in Table I is necessary because examples of each are in service today:

A. *Switching* circuitry became widespread with the dial telephone. Dial systems use fixed or hardwired switching logic—that is, the switchboard wiring pattern must be physically in order to change the number of a given telephone receiver.

B. *Programable switching* includes the touch tone dialing phones and the U.S. Government Advanced Research Projects Agency (ARPA) computer network. In the latter system each standardized message has its own address, like a package of mail, and is relayed from sender to receiver. Both systems will accept rerouting instructions as special message inputs; this makes possible a dynamic update of routing. Someday, one could envisage as a practical reality a computer-assisted locator service that searches several locations automatically, or reads rerouting commands left by the receiving party, in order to relay a message or make telephone contact.

C. *Computer services* are already part of the nation's telecommunications network for airline reservations, banking and credit transfers, and scientific programming from remote terminals. *This feature warrants distinction because every one or two years successive computer designs double in speed, logic density, storage capacity, and computations per dollar!* [7] Such rapid development shifts relative costs in favor of the computer based alternatives.

D. *Off-line memory* at central facilities and *Storage* at user sites perform similar roles. Any form of memory or storage offers increased schedule flexibility in the use of the channel, often the option of using a lower capacity channel to send a large block of data over a longer period of time, and the advantages of permanent—or semi-permanent—records for later reference. All computers have some memory, but it is generally fast electronic memory that is needed to carry out calculations or remember instructions—this is called on-line memory. Off-line memory has a slower access time of much greater capacity. It can be in the form of magnetic tapes, disks or drums. It could be recorded photographically or even on punch cards and paper tape. But it must be "machine readable" by a computer for easy electronic access. Information look-up, manipulation and display, are the heart of many business, research and recreational activities. Text editing by computer from a remote terminal has most of these features; the computer retains previous draft versions before editing so the development steps can be retraced; sensitive material may be deleted on command so only summary sections are printed; and many different formats are available for final publishing.

There are other user facility features with broad ranges of application:

1. *On-line channels* are the basic promise of subscriber response cable television. Applications include all sorts of health monitoring, burglar and fire alarms, traffic control, educational interaction with a computer tutor, and so forth. These same response services could be provided at moderate costs by multiplexing the local phone or power lines.

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[7] James Martin, "Future Developments in Telecommunication," Prentice-Hall, N.J., 1971. See also Fortune, "Here Comes the Second Computer Revolution," November, 1975, Vol. XCII, No. 5, pp. 182–184.

2. *Mobility* offers obvious advantages such as keeping in touch during a long commute home and coordinating a fleet of repair vans or taxicabs. Possible future applications are: providing a television picture of a patient while still in the ambulance or distributing the services of hospital and school staffs to mobile clinics or classrooms.

Several groups have assembled extensive lists of user services offered or promised by telecommunications technologies: James Martin of the IBM Corporation,[8] the MITRE Corporation,[9] the RAND Corporation,[10] and the Sloan Commission,[11] to name a few. The primary emphasis of the MITRE, RAND, and Sloan Commission studies was to explore the household and institutional uses of broadband transmission—predominantly as a consequence of extensive distribution of television by cable. Multichannel television promised by cable could be broadcast at lower cost in sparsely populated areas and even in some urban areas. Because full fledged stations cannot seem to find sufficient support, many UHF channels remain unused.[12] In general there is more than one technology appropriate to each service.

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[8] James Martin. *op. cit.*, 1971.

[9] William Mason, *et al.*, "Urban Cable Systems," MITRE, 1972.

[10] Walter Baer, *et al.*, "Cable Television : A Handbook for Decision Making", and RAND series sponsored by NSF, Rand Reports : R–1133–NSF through R–1144–NSF, 1973.

[11] The Sloan Commission, "On the Cable, the Television of Abundance," McGraw Hill, 1971.

[12] Rand Corporation, "Projecting the Growth of Television Broadcasting," R–1841–FCC, 1975.

TABLE II.—THE APPLICATION OF TELECOMMUNICATION TECHNOLOGIES AND USER SERVICES

[Key to symbols—X: used today; 0: could be used; r: return path only; R: required, no substitute]

	Technological options											
	Hardwired				Broadcasting			Terminals				
User services	Powerlines	Twisted pairs	Coaxial cable	(Fiber optics)	Microwave relay	Radio-television frequencies	Satellite	Switching	Programable switching	On-line channel	Computer services	Storage memory
Local phone service	0	X	0	0				R	X-0			
Long distance phone service			X	0	X		0	R	X-0			
Telephone conference		X	X	0	X		0	R	R			
Mobile telephone						R		R				
(Broadband land mobile (Medibus))					0	R						
Local TV			X	0		X	0					
Network TV distribution			X	0	X		0					
Pay television, MDS			X	0	X	0						
(Wide area 2-way TV for medicine, education, or government).			X	0	X	0	0		0	X-0		
(Alarms and monitors)	0	0	X-0	0						R	R	
(Power switching and automatic control)	0	0	0	0				R	0		R	X
Industrial process monitoring		X	0							R	R	X
(Polling subscriber responses)	r	r	0	0		0				R	R	
Transportation coordination		0	0	0					0	R	R	X
(Unite (vehicle) identification)	0	0	0	0		0		R	R	0	R	R
Reservations and scheduling	0	X	0	0	0		0	R	0		R	R
(TV quiz with audience response)	r	r	0	0		0				R	R	
(Interactive education)	r	r	X-0	0	0	0				R	R	R
Electronic fund transfer and credit	0	X	X-0	0	X-0			R	0		R	R
Information search and access	r	X	X-0	0	X-0			R	0		R	R
(Catalog shopping)	r	r	0	0	0	0				R	R	R
Computer-to-computer data exchange		X	0	0	0		0	R	0		R	
Hardcopy visual image transfer		X	0	0	0		0	R	0			
On-demand full computer services			0	0	X-0		0	X-0	0	X-0	R	
Text editing	0	X	0	0						R	R	R
(Locator service)	0	0	0	0	0		0	R	R		R	R

Note: Parentheses represent technologies or services that are only in the experimental or early stages of development.

Table II illustrates the possible services available if the regulatory, political, economic, and competitive constraints were removed. These services are presented in the lefthand column and have a wide range of institutional as well as residential applications, various distance and information capacity requirements, and both profit and non-profit services.

Many of these services have been discussed before as examples of applications of the various technologies which are again listed along the top of Table II. Parentheses designate user services or technologies that are only in the experimental or early stages of development. The entries in Table II represent the pattern of possible utilization of the technologies in providing the various services. The high degree of flexibility of purpose and interchangeability of various telecommunications technologies is revealed by the high density of entries in the table as a whole. The codes used distinguish existing technologies and applications from those discussed as possible or expected option. The entries designated by an *X* are applications in service today; a code X-O shows limited application in an area with expected growth or alternative modes of use; and those designated *O* are either not yet in practical use or are in the developmental stage. Most of these have as yet unproven markets and represent both high risk and great promise. The capital *R* designates a *r*equired component for the service, while the small *r* designates a low capacity *r*esponse signal path to complete a two-way service option when the primary signal is distributed by broadcasting options.

Several general relationships are revealed by Table II:

First, in most cases there are several alternative communications channels or combinations of channels that could provide a given service. For example, subscriber response television almost immediately brings cable television to mind, but in remote rural areas broadcast distribution with telephone return paths may be the only economically viable alternative.

Second, many services require a combination of several channels and terminal features; these may not all be supplied by the same institution. An example would be power switching of non-essential residential and commercial loads, which requires a low information capacity addressable channel to each on-off load switch. The power company would supply the load switch, but the channel could be over telephone lines, a cable tv link, or the powerlines.

Third, many of the technologies, new and old, can support a host of applications. This would expand the economic base of support and increase the demand for the technology if there could be a general sharing of its use. For example, coaxial cable can be used for nearly all applications except land mobile. This holds even if one distinguishes trunkline telephone cables from household subscriber CATV and industrial plant two-way broadband applications.

Both cables and microwave links can unite educational, medical and governmental institutions into a two-way broadband network; these same channels could also distribute network or local television programs in order to supplement operating revenue.

Fourth, most of the services expected in the near future require a computer; they also require either or both computer assisting capabilities—an on-line channel or storage option. Subscriber response cable television requires a small on-line computer. As demand for computer services increase, cable systems and phone linked computer access terminals may be in direct competition. Polling of television audiences by subscriber response, audience response tv quizzes, and interactive education require an on-line channel to the television program origination studio. This on-line channel could also supply burglar and fire alarm connection.

Fifth, all but the multichannel television service and land mobile applications require either a switched network or an on-line channel to a computer. These two are not clearly distinct alternatives since the telephone dialing operation is in reality the use of an "on-line" channel. The chief difference is in the interconnection complexity of a telephone network compared with the many-to-one simplicity of on-line CATV channels. Alternatively, cables could provide local phone service if sufficient channels were devoted to cover the traffic demand of all users on a cable distribution trunk—and a central computer provided the costly switching functions. Since one television channel can be multiplexed into 1700 telephone lines, this option is not out of the question given that the cable is already in place to provide multichannel tv and subscriber response features. As a result, the roles of broadcaster and common-carrier could eventually merge technologically. What this would do to competition, FCC regulations, and the sociopolitical environment needs to be studied and carefully assessed.

Sixth, because the telephone system and the broadcasting industry already have a worldwide distribution network, new applications of telecommunications interfacing with these established systems could easily have a reach that would extend around the world, crossing all political and decisional boundaries as well as geographic limits. Moreover, the interdependence of both services and technologies will constantly produce adjustments in the old to accommodate the new. The scale and reach of each technical application will continue to determine the commercial viability of many businesses which depend on, or compete with, the telecommunications services.

SUMMARY

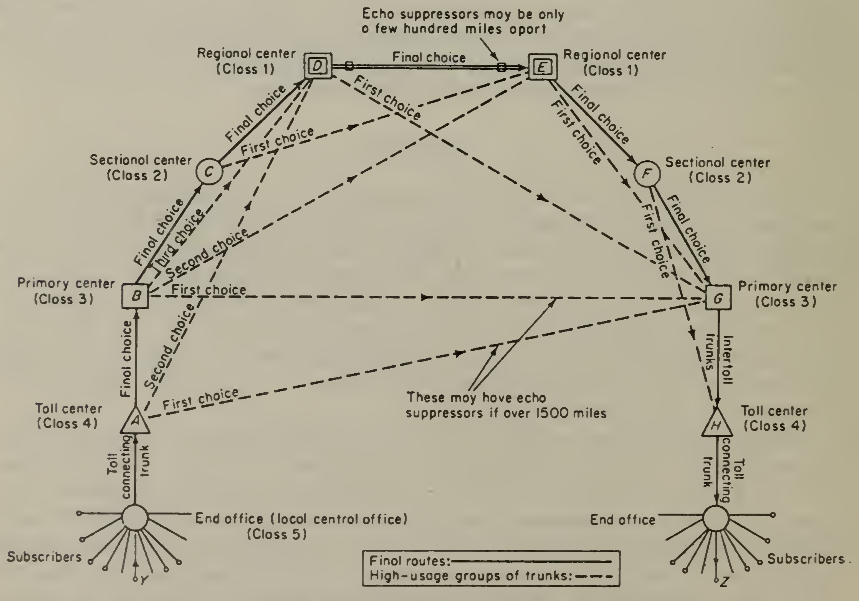
At best, this has been merely an overview of changing technical realities and emerging services in the field of telecommunications technology. We know little about human communications and little more when it is handled electronically. New applications often come rapidly when the conditions are ready—television spread from 20 percent to 80 percent of all U.S. households in only six years. Therefore, the processes of growth and change could come very rapidly, and perhaps faster than either the precedent or the base of experience upon which wise policy often depends.

This should act as a warning for all policymakers—for the White House and the Office of Telecommunications Policy, for the Congress, for the Federal Communications Commission—and for all others who have an interest in telecommunications. Electronic and telecommunications technologies appear to be on a competitive collision course and there is the promise—some would say the threat—of the giant in computer technology, IBM, competing with the giant in telephone technology, AT&T, and the giant in postal communication, the U.S. Post Office. All of them have a stake in the future of telecommunications along with ComSat and the communications satellite manufacturers, the broadcasters and the cable operators, among others. The era of an integrated telecommunications system is possible with current satellite, microwave, cable, and computer technology. All we need is the appropriate policy to decide how the mix will be handled and by whom. But these decisions will not be easy.

In an area as complex and dynamic as telecommunications policy making can be difficult, even hazardous, because of conflicting public interest considerations. Legislation in the area of telecommunications raises another set of problems because its scale, its scope, its interrelatedness, its pervasiveness, its dollar investment, its rapid turnover, its high quality, its impact on almost every aspect of our daily lives, give telecommunications technology a unique position in society. Furthermore, telecommunications technology overrides all the traditional boundaries of governmental authority.

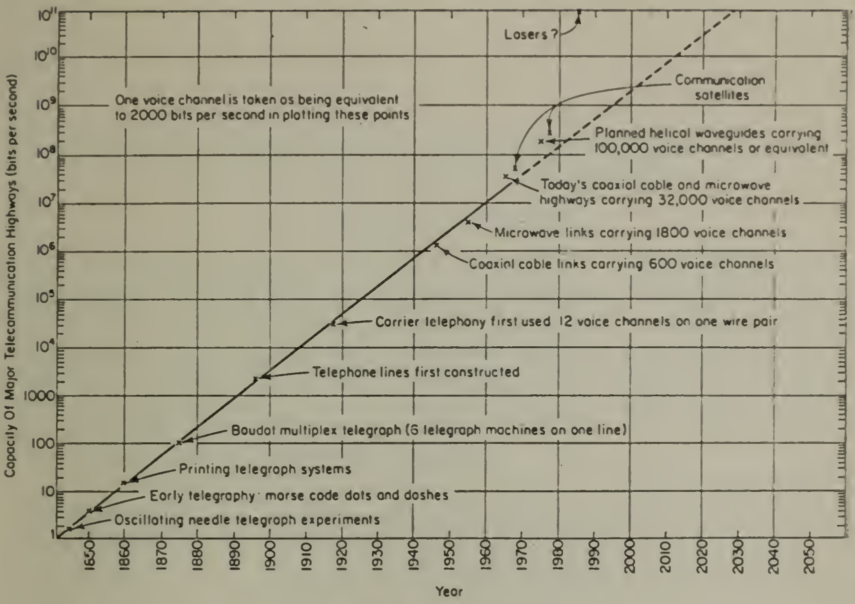
Many of the effects of telecommunications technology, because of political resistance, economics or status quo thinking, are delayed, slow-moving, accumulative, and outside the chain of responsibility of buyer, seller, and individual government agencies. In other words, no one has either overall authority or mapping responsibility with regard to what telecommunications technology has been doing, is doing, and will undoubtedly continue to do on a greater scale in the future.

All of this places a very heavy burden on the legislators, the bureaucracy, the telecommunications industry itself, the public interest groups, and the academic and research community. Some very difficult decisions lie ahead; let's hope that these decisions will be as innovative, as flexible, and as far reaching as the technology they hope to implement.



Choice of paths when Y dials Z. A typical long-distance dialing network.

Reference: James Martin, op. cit., 1969, p. 321.



The sequence of inventions in telecommunications.

Reference: James Martin, op. cit., 1969, p. 8.

A RECOMMENDATION REGARDING TELECOMMUNICATIONS RESEARCH IN A RAPIDLY CHANGING ENVIRONMENT

By Raymond M. Wilmotte[1]

The Federal Communications Commission, among others of our institutions, is facing the very difficult problem of change. Major aspects of the environment in which it operates are changing rapidly, rapidly enough that looking at the past is not a very good guide for meeting the future. Not only are the forces and attitudes in the public arena changing, but so is our economy and our technology. Problems are becoming more complex because of rapid and complex interactions, and solutions much more difficult.

Until recently, it seemed necessary only to regulate transmitters, the communication system component that generates energy which might interfere in the service areas of other transmitters. This policy was adequate since the amount of spectrum that we know how to use was sufficient for the public's needs. That situation has now changed. It often appears that new radio services, and indeed, individual communication systems can often be accommodated only by sharing or reallocating the radio frequency spectrum. It is now clear that entire communication systems consisting of receivers, transmitters and all the other elements that may be in the path between them need to be regulated.

The regulation must insure that systems do not interfere to an unacceptable extent with each other. In technical jargon, this is known as electromagnetic compatability. While the compatability between systems must be maintained, the density of operating systems must be increased to allow for the increasing demands and needs of the present and of the future. We need to develop a broader understanding of these complex problems to keep pace with the changing telecommunication environment.

The changing environment requires the continuous review of old policies and the development of new ones. Modification of the old and formulation of new policy depends on broad overviews of existing conditions, and research into the consequences of making changes, or of failing to make changes. Planning research is difficult. To be effective it must have a coherent structure in which the several elements of it focus on some fairly specific common purpose. These needs are making a heavy demand on analytical capability. Fortunately, automation has struck the field of analysis. Led by the computer, the minicomputer and the calculator, there is a plethora of techniques and tools allowing the analyst to do in minutes what might have previously taken him days to do. These tools and techniques are great, their potential enormous. The changing environment demands the introduction of these new methods into the research process to help the development of policy.

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[1] Dr. Raymond M. Wilmotte is a consulting engineer in the fields of electronics and technology management. He holds his doctorate from Cambridge University, England. For most of his professional career he has been consultant to the broadcasting industry and major electronics corporations. Of recent years, he has been mainly consultant to government agencies and the National Academy of Engineering. During the war he operated his own laboratory and production facility. He was awarded the Bureau of Ordnance Development Award. He has published some fifty papers and articles in the professional press and has been granted nearly fifty patents.

The rate at which these changes are taking place is making a heavy demand on the various decision levels within the Commission and on the Commissioners themselves. It is clear that the effective and smooth meeting of these problems will depend to a considerable extent on the relationship between the analyst and the decision-maker. In this paper, I will refer to the decision-maker as the level at which a decision has to be made. This will include the decision levels within the staff of the Commission as well as the Commissioners themselves.

The decision-maker has two alternatives in seeking to develop an objective picture and understanding of the situation about which he is to make a decision. The first is the quasi-legal one of obtaining the truth from the "biased" presentations of parties with conflicting points of view. The second is to turn to the profesisonal analyst and his presumed objectivity in his search for truth, which may not be generally available from parties standing to gain from the decision. A goal of the professional analyst is, therefore, to present to the decision-maker an assessment of the situation which is as free from personal bias as possible.

The professional analyst, however, inherently suffers from a bias arising out of his expertise. The bias is not of the kind that favors one side of a controversy or another, but exists because the analyst automatically favors the problem areas and approaches that he can most effectively deal with. This may be difficult for the non-expert to recognize and detect. To a degree, this bias is inevitable; to a considerable extent the analyst can be helped by procedure to minimize its effects. This bias left uncorrected, will nearly always affect the decision. Generally, the effect will rest unnoticed.

The manner in which this bias enters into the decision process is typically as follows: the analyst, when assigned to a problem, breaks it down into its principal component parts, and asks himself what can be done to attack each one. Inevitably, he thinks first of the things that he himself can do, of the things that he can do well. The things for which there is inadequate information or those things in which he is uncertain of his capability, will tend to receive secondary consideration or no consideration at all. A great many analysts of repute try to overcome this bias, but few can resist the temptation to give priority to those things which he finds easy to do because of his expertise. It gives him confidence in his ability to resolve the whole program and inspires the decision-maker with confidence that the problem is in good hands.

While these are good psychological reasons for producing useful results early in the program, one would expect that it would be better and more efficient to attack important and difficult things first, in case it was found that the difficulties encountered might affect the planning of other parts of the program. Occasionally, the impulse of the analyst to do those things that he knows how to do well is sufficiently strong that he will plan, and actually carry out, experiments and analyses which he expects will be useful, without giving serious consideration to their form or how they are to be applied to the assigned problem.

This kind of bias has a subtle quality. It fits well, almost ideally, with the analyst's attitude and psychology, and it is difficult for the decisionmaker to detect it because it is an inherent part of the analyst's expertise. It is probably impossible to completely eliminate its impact. But it is possible to reduce it to a considerable extent when the analyst recognizes its potential dangers and is willing to adopt a counteracting procedure. This typical planning process is one tending to *adapt the problem to the things the analyst can do.* The process, or rather the principle, described here focuses on *adapting the things to be done to the needs of the problem.* It is the conceptual stage which will guide the whole program. It is a process for systematically developing the basic approach and modifying it as circumstances and findings require. The focus is on thinking; the organization of the action, of carrying out the analyses, comes later.

The first step after defining the problem and the boundaries beyond which the analysis will not extend, is to list as specifically as possible the outputs desired of the program. The objective of the program is to provide the decision-maker with information which will help him to understand the scope and ramifications of the problem, and the facts, quantitative and qualitative, which will help him to reach a rational decision.

The analyst, in selecting the information he presents to the decision-maker, has used his judgment. This judgment implies the existence of factors on which it was based. The program outputs must, therefore, include the set of factors on which the outputs are based and can be assessed. The list of factors is an important feature of the process, for the analyses to be carried out will be directed to the means of assessing them. Often the analyses will lead to defining a number of alternatives and the comparative assessment of the factors will spell out their relative advantages and disadvantages on the basis of which the analyst can make a recommendation and the decision-maker a decision.

The first step in the program is very important. The list of criteria should be made without any consideration of whether it is easy or difficult, possible or impossible, to evaluate the output information. These factors are to be considered later in the process. This means that the analytical process will be focused on estimating the criteria, if the analyst will adapt his approach to the needs of the problem rather than the other way around. Needless to say that the only effective way in any slightly complex situation is to put a list of factors in writing.

The second step is to make a list of the readily available inputs which will be used in the analyses—the condition which initiated the need for a decision, its background, literature, data bases, models, analytical talent, etc. The analyst is to convert these inputs into the desired outputs as fully and as objectively as he can. To do this he will have to break down his analytical approach into component analyses focused on providing assessment of the factors required by the desired outputs. The structure of the analyses will generally be displayed in the form of a tree showing clearly how the output of one analysis becomes the input of another.

The tree, therefore, depicts the programs approach to the problem and the relation of the component analyses to each other. The tree can conveniently be called "a problem tree." It is a highly visible way of describing the approach to the problem. In constructing the tree the analyst will develop a better understanding of the nature of the problem and the needs of the decision-maker. In so doing he will also discover the extent to which he can provide the information required to produce the desired outputs. At this point he can then make a rational decision, in view of constraints in time and cost under which he is to operate, as to which analyses he should try to carry out and to what depths. He will also turn his attention to what he can do and to what he cannot do toward achieving the desired outputs of the program. More often than not these desired outputs cannot be fully achieved. It is important for the analyst in planning his program to have a rough assessment of how the output is expected to meet the needs of the decision-maker.

The development of a problem tree along this line of approach will generally give the analyst a much deeper understanding of the nature of the problem. This results in the analyst becoming aware of alternative approaches which might not have come naturally to his mind had he followed the normal process. That process inevitably restricts the scope of his imagination.

A warning should be given to those interested in applying this problem tree approach. On the face of it it looks simple enough, but it requires a major change in attitude and focus on the part of the analyst from the more usual process of planning what to do, but at first it seems foreign to normal habits; there is a constant tendency for changing the focus from what the problem needs to what the analyst can do, making it difficult at first to build an effective problem tree.

The results are worth the effort. The problem tree has certain special advantages. It provides a simple picture of the approach used in the program, making it useful for communicating with the decision-maker and other interested parties. It gives the analyst a clearer picture of the areas in which he should direct his effort to produce the most useful results within the time and cost limitations. At a later date he can return to this or to a similar problem, and instead of starting from scratch, he could start where he left off, attacking certain analyses which he had not been able to carry out previously. The tree will also show him where disciplines other than his own would contribute effectively to the program. Bringing several disciplines together seldom produces a coordinated result. That occurs only if a coordinated procedure such as that outlined is systematically carried out. Finally, the problem tree will help the analyst to convey to the decision-maker his understanding of the problem, the extent to which he has been able to cover his principle aspects and, very important, he can indicate the areas he has been unable to cover.

The pressure of change, and the greatly increased complexity of the problems facing the Federal Communications Commission, is putting a heavy strain on the Commission and its staff. Effective research and development of policy are becoming increasingly important, and with them the objectivity of the analyses on which decisions are made. As discussed in this paper, this objectivity is seriously impaired by the inevitable bias on the part of the analyst due to his expertise. The problem tree approach overcomes this difficulty, and has a number of other valuable characteristics that have been previously discussed.

The principles outlined here are particularly suited to the present and coming problems of the Federal Communications Commission, such as in the area of electromagnetic compatibility. It seems apparent, however, that they can be applied to a wide range of problems in government and industry outside of the telecommunications field.

APPENDIX

THE PROBLEM TREE CHART

The chart in the attached figure shows on the right a box entitled "outputs". This box lists the types of information that it is desired to convey to the decision-maker. The outputs box includes the factors on which the selection of information was based. This lit of outputs is preliminary. It will be revised by an iterative process as the analyst's understanding of the problem develps.

The left box of the top line is simply a description of the condition that initiated the need for a decision and may include the background of how this condition arose.

Underneath that box is the one labeled "inputs". The inputs are readily available information which can be used for any of the analyses.

The center block on the top line called "integrator" combines the outputs from the level 1 analyses to produce the desired program outputs.

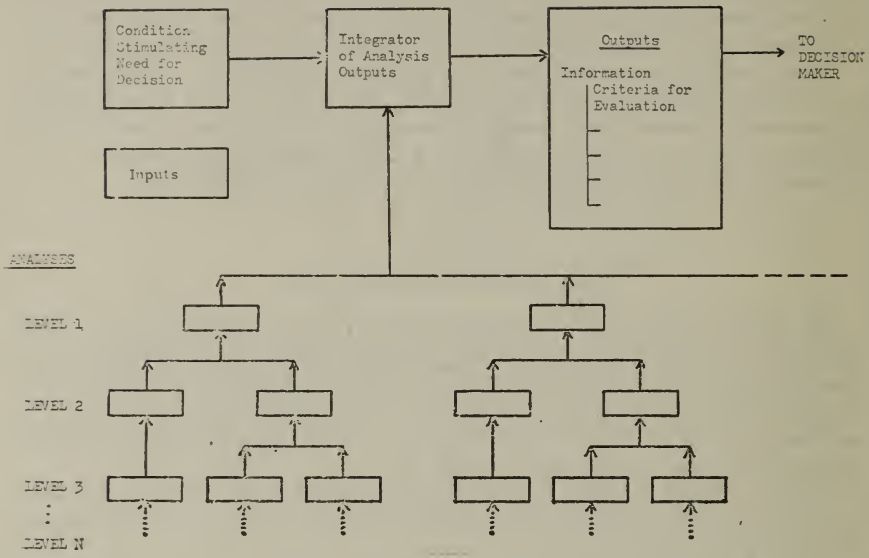
The component analyses of the program form the branches of the problem tree. These branches are developed without consideration whether or not the analyses can be carried out.

The analyses are divided into several levels. Level 1 comprises the analyses needed to carry out the integration process. This process will produce the output information that is needed to evaluate the output factors. Level 2 comprises the analyses required to provide information for the analyses of level 1, and level 3 provides information for the analyses of level 2, and so on.

In building this structure, two principles should be maintained. First, the analyses in a level should interact as little as possible with each other. Second, the output of a lower level analyses may be an input to more than one analysis at a higher level.

After the problem tree has been developed consideration should be given to ranking them in order of their importance in affecting the program outputs. Then attention should be turned to the depth to which they are to be carried out and how best to do so. At this point an "action" chart may be drawn (such as a Part or bar chart) outlining the sequence in which the analyses should be performed and the depth for each one in view of the constraints of budget and schedule.

PROBLEM TREE



THE COMPUTER CONNECTION [1]

By John Eger

(Acting Director, Office of Telecommunications Policy, Office of the President)

When I was a kid growing up in Illinois, kids used to collect and trade bubble gum cards. With each stick of bubble gum you bought, you got a baseball card with a player's photo on one side and a record of his professional career on the other.

Now that I am living in Washington, I find that the same collecting mania exists here, only the collectors aren't kids and the objects collected aren't baseball cards—they're called dossiers. They don't always have pictures, but they always do contain the record of someone's life.

As with baseball cards, dossier collectors, some say, operate with a compulsive need to get the "complete set" and thus collect more and more all the time. Like baseball cards, dossiers get "traded," too. But thanks to computers and modern telecommunications capabilities, dossier trading is a lot more efficient than the baseball card swaps we remember from childhood. Today you don't have to give up one of your cards in order to get one from the other guy; you merely arrange for your computer to telephone his computer; then the computers make copies of each other's cards. In some cases, with the assistance of a little more advanced telecommunications technology, you don't even need to make copies. Instead, you can look at any dossier in his computer collection just as easily as you can look at one in your own and vice versa. All the other collectors can get in on this act, too, so as soon as one has a dossier on a particular subject, every collector has access to it. With modern technology every kid on the block can have all the cards available.

When we were kids collecting baseball cards the only effect of our collecting and trading was to decrease our cash and increase our cavities. The effects of dossier collecting and trading are far more grim.

Operation of a society as complex as ours necessarily entails the efficient collection and transfer of records and information. However, there are substantial dangers inherent in the utilization of telecommunications technology to accomplish those goals. These dangers include, simply stated, the aggregation or disclosure of personally identifiable data passed on to unauthorized or improper persons or agencies. Libraries know what we read; telephone companies know to whom we talk; banks and countless credit agencies know our financial worth; the IRS knows, if we itemize our deductions, what church and charities we support; and so on in an ever-widening spiral of commercial and government records and personal information files that would tell anyone who puts them all together a lot more about us than anyone has any business knowing.

The linkup of computer systems, some containing records on individuals, is happening now. The threats to privacy are apparent and growing. Fortunately, the public awareness of those threats is also expanding. It's difficult to discern from the scattered and sometimes apocalyptic news reports exactly what's going on, but public concern has recently centered on three Federal systems: the FBI's NCIC, the General Services Administration's FEDNET and the Defense Department-operated ARPANET.

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[1] Reprinted from *Sky*, November 1975, East/West Network, Inc.

The FBI wants to alter its National Crime Information Center System to link the criminal history files of every state and local police department, corrections systems, prosecutor's office and court system in such a way that, allegedly, if you were stopped for a defective taillight anywhere in the country and a routine criminal history check were made, the FBI would know of the encounter, as would anyone else with access to the system who was interested in what you were up to. This is even more disturbing when you realize that a great portion of all police contacts with citizens, resulting in messages that might flow through the FBI's proposed system, do not involve criminal behavior at all.

A second proposal, now pretty much dead, was the General Service Administration's FEDNET (Federal Network) plan for an integrated block of computers large enough to store far more information than the Federal Government was likely to ever need. The FEDNET system would probably have streamlined GSA procurement and property management efforts, would have provided the Department of Agriculture with a highly centralized capability and would have made available a large reserve capacity for meeting future, but unidentified, needs of other Federal agencies. However, in the opinion of the Office of Management and Budget and then Vice-President Ford, insufficient consideration had been given to protecting the individual's right to privacy.

The third system, recently noted in the press, run by the Defense Department's ARPANET (Advanced Research Project Agency Network), links through a high-speed, relatively economical network the research computers and many universities and allows one data base to talk with another. Here, too, questions have been raised about whether adequate safeguards to individual privacy have been developed.

All three of these systems and others have at least two elements in common. First, they all incorporate advanced computer and telecommunications technologies for greater economy and efficiency, and second, they pose a threat to privacy by making it *easier* for Federal agencies to collect information on citizens and, having collected it, pass it on to other agencies.

FBI Director Kelley feels that the Bureau's proposed system would increase his agency's efficiency. The other agencies whose proposed systems are cause for concern undoubtedly feel the same way and they may well be right. But the probability is that installation of many of those systems will be disapproved because of their perceived threat to privacy, before anyone gets around to asking whether—privacy aside—the systems make good sense in terms of efficiency and economy. When these threats to privacy occur, as they do today, in a climate of distrust for both big government and big business, then those of us who feel that advanced computer and communications technology are essential to good government and to a growing economy, had better get our houses in order—or they'll be pulled down around our ears.

The initial reaction to these threats to privacy is liable to concentrate on the first characteristic the systems have in common, namely, that they all use the latest technology, taking the most powerful computers and compounding their power by linking them with sophisticated telecommunications capabilities. One could easily, but erroneously, conclude from this that the dangers lie in the technology itself and that the cure lies in prohibiting or at least delaying the development of new technology.

This is already happening. Senator Proxmire introduced a bill which would impose a moratorium on electronic funds transfers for 18 months. Also, there is talk of greatly restricting all computer interconnection. It would not be surprising to witness an urgent call for a moratorium on all new computer systems. But such action would do nothing to resolve the problem; it would only postpone a forthright dialogue, obscure the issues and set back the development of computers and communications in this country, to everyone's detriment and to no one's gain.

Computers and telecommunications, which make up the most rapidly growing sectors of the United States economy, are essential to increasing our national productivity. Currently, the United States leads the world in the technology of computers and telecommunications. But if we try to protect privacy by attacking the technology, we may lose this lead, throw our computer and communications industries into disarray and do grave damage to the long-range health of our economy—and to make the whole experience still more painful, when we had finished, we would find that we had still not dealt with the problem of safeguarding privacy.

The troublesome but certain truth is that we cannot solve the privacy problem by manipulating the technology. We don't collect data on individuals because we have computers which can handle it; rather we build computers and join them with telecommunications because we want to take the data we have been collecting all along and either do new things with it or, more commonly, do the old things more efficiently.

Think of the invasions of privacy that took place in Watergate. Many of those involved the misuse of Federal records on individuals, but probably none would have been prevented by prohibiting computer interconnection. The solution is plainly not technological. The only real solution is enactment of laws which give affirmative protections to privacy, which allow people to control the ways others use certain information about them—in much the same way they can already control the use of their names or likenesses by advertisers. If we get this sort of protection it won't matter which technology is used.

So we are at a crossroads. We can either become the new Luddites—taking a legislative axe to the computer—or we can begin the much harder work of establishing the sorts of protection which will suffice against tomorrow's technology as well as today's. We already have the Privacy Act of 1974, which provides moe protections regarding Federal government records. We should strengthen its provisions, and also devise protections suitable for records maintained by private organizations. The first step is to determine exactly what privacy protections we have now and what their weaknesses are. The Office of Telecommunications Policy has recently completed an analysis of the existing legal and ethical safeguards which hopefully will serve as a working guide in drafting the new protections which are becoming increasingly necessary.

We have to set about this task now. The questions that must be resolved are so complicated, and in some cases so touchy, that it will take time to achieve a political consensus on the fundamental policies. Drafting and implementing laws and procedures to activate these policies will take still longer, as those of us in government who are struggling now to implement the Privacy Act are finding out.

But if we want to have comprehensive protections in effect before we reach 1984, either chronologically or metaphorically, we must begin today. If we dawdle or try to deal with the dangers through inappropriate means, we may find ourselves several years from now forced to employ much more dramatic and expensive remedies.

CLOSED-CIRCUIT OPTICAL COMMUNICATIONS

SPEECH TO NATIONAL ASSOCIATION OF EDUCATIONAL BROADCASTERS, NOVEMBER 17, 1975

By Dr. Herbert A. Allen—Arthur D. Little, Inc.

People will little remember or are even aware that a "silent explosion" occurred in 1975. This silent explosion is more than just the ability to transmit over short and long distances at wideband (>1 GHz) at low cost and extremely low volume optical fiber cables.

Seven simultaneous events are occurring:

(1) An entirely new glass technology that reached achievement in 1975 will be publically announced in 1976, which will affect electro-optic components, sub-systems operation and cost;

(2) Government-sponsored fiber optic communication programs in the U.S., Japan, Germany, France, England and Brazil received approval to proceed in a major way in 1975 as well as other countries;

(3) Communications needs, driven hard by energy *crises* and now the easing of recession, are receiving a surge of investment in teleconferencing, telecommuting, telecontrol, supervisory control, and education methods;

(4) Military, industrial and computer system fiber optic needs are being funded aggressively on four continents;

(5) Fiber optic electronic mail systems design has begun;

(6) The requirements of the evolution towards an "information society" with growing educational, social and medical needs are being aggressively addressed; and finally

(7) The incentive of the multi-billion dollar fiber optic communications market beyond 1980, and its present active role in world trade agreements has attracted major groups and investments, worldwide.

The four basic ingredients of communication, namely Transmission, Switching, Terminals, and Use, are being addressed in a cost/effective manner in high growth areas of fiber optic communication: areas that as little as a year and a half ago seemed far off. Costs for broadband are not much different from narrow band, and optical systems for selective, internal communications, CATV, or interactive CATV calculate to be cheaper systems than copper cable systems. Such systems *will* be cheaper, better, and will go further, providing switched video for institutions and in the home. Switching techniques of the large-scale integrated type will be employed first in such systems, but pure optical switching and optical repeaters already exist in the laboratory, and also micro-optics sub-systems in developed forms. New, cheaper terminals that fit with fiber optics are under development, because of all the basic ingredients, display is the most costly. The displays operate in analog or digital environment. With cheaper switching, transmission and display, extensive uses contemplated in wired city and educational services become technically and economically feasible. To this is added the new automated manufacture, maintenance, and automated communications under development. In 1975, some of these are now developed.

In 1975 many new optical communication modulators were developed, as well as production connectors, splicers, and service equipment. In 1975 a switched closed circuit fiber optic television system became available in limited quantity. The advances in 1975 were so positive that *perhaps* in 1976 fiber optics CATV trunking will begin to be installed as well as *perhaps* a 1976 T3 system in Georgia by ATT; *perhaps* a T1 (1.544 Mb/s) system by G.T.E. in California in 1976; and *perhaps* a low and high frequency fiber optic system in Great Britain in 1976 (8.48 Mb/s and 139.264 Mb/s); and *perhaps* a major CATV system with a wide variety of services starting by 1977; *perhaps* new micro-processor-controlled C.P.U.'s to service such systems by 1977; *perhaps* a projected cable cost drop of an order of magnitude within a very few years; and *perhaps* even experimental satellite drops to an earth station furnished with fiber optic distribution.

As you know, Arthur D. Little has been a conservative-speaking, but innovative industrial consulting company for the past 90 years, and for those who know of my own prior work, I also tend to talk only after detailed appraisal. *Those* people who know that, can erase the word *perhaps* from all my previous statements.

The "silent explosion" occurred in a major way in 1975. It may be followed by other lesser quiet eruptions. It has so far not been noticed by many expert executives, analysts, and communications directors despite their highly developed marketing intelligence systems and technology intelligence systems. However, the "fallout" should hit them soon, and in some cases it may take 0–4 years, depending upon their areas of work.

If you cannot hear "The Silent Explosion" of 1975, or still do not have sufficient input to analyze it, you will nevertheless soon see and feel it as the four basic ingredients of transmission, switching, terminals and near term uses and methods of delivery and flexibility for change of use through enormous bandwiths with local individual access and a multiplicity of services in a cost/effective way. They are here now, and software improvements are technically possible to be as simple or as complex as the user may want.

VALUE CHOICES IN ELECTRONIC FUNDS TRANSFER POLICY

James B. Rule

> "You can look at my bank book, but I'll never let you get your hands on my purse.—Bessie Smith, from the song "I've Got What It Takes (But It Breaks My Heart to Give It Away)"

OFFICE OF TELECOMMUNICATIONS POLICY,
EXECUTIVE OFFICE OF THE PRESIDENT,
Washington, D.C., October 22, 1975.

Hon. NELSON A. ROCKEFELLER,
Chairman, Domestic Council Committee on the Right of Privacy,
Washington, D.C.

DEAR MR. VICE PRESIDENT: I am forwarding the enclosed study to you as Chairman of the Domestic Council Committee on the Right of Privacy. The study, *Value Choices in Electronic Funds Transfer Policy*, is a critical and long overdue examination of the broad range of issues beyond the economic which face us in the development of Electronic Funds Transfer (EFT) systems in the United States.

Government activities and policy making regarding EFT deeply concern the Office of Telecommunications Policy. Both because of our particular mandate to evolve policy relating to the interconnection of computers with telecommunications, an interconnection which is the necessary foundation of any EFT system, and because of our concern for informed and effective formulation of policy in the executive branch, OTP has begun to scrutinize closely the increasing range of Federal Government activity in this area. In order to facilitate efforts directed toward making responsible policy decisions, we commissioned Professor James B. Rule of the State University of New York at Stony Brook to prepare the accompanying report.

The report addresses the range of non-economic issues of concern to OTP within an original and provocative framework, providing a fresh and extremely useful perception of the relation of social change to technological innovation. The focus, as the title suggests, is on value choices which must be made in the evolution of EFT. The study presents a needed foundation for examining how those choices can be made. By focusing on the need for determination of long-term goals and for resolution of conflicting value orientations, the study sets the stage for reasoned inquiry, discussion and debate.

On a more concrete level, the study explores the social aspects of EFT development, such as the impact on individual autonomy of EFT and the social consequences on transforming our standards for enforcing obligations, issues which until now have been ignored or, at best, inadequately considered. Dr. Rule's examination of EFT as a "novel social resource" provides perspective for better understanding the changes which EFT will bring to our nation. Further, the study clearly spells out the characteristics of bureaucratic information systems, their use for social control today, and the likely impact of EFT on the structure and function of such systems. The discussion emphasizes in concrete terms the probable effect of EFT on informational privacy, as well as examining a broad range of related consumer concerns.

Though it provides no final answers, the study forces to our attention the fundamental questions which must be resolved as EFT evolves—whether that resolution is a product of design or circumstance.

In directing preparation of the report and in beginning to employ it as a building block in the development of executive branch policy regarding EFT, two factors have been of greatest concern to this Office. The first is the dearth of examination by those now beginning to shape national policy of the broad non-economic policy questions raised by EFT; the second, and even more important, is the proliferation of forums in which policy is being fashioned and the often conflicting and parochial interests of the various parties who are making important policy choices.

On the substantive level, OTP is concerned over the Federal Government's role in EFT development. This Office believes that there are serious and as yet unresolved questions regarding (a) whether the Federal Government should have an operational role in EFT, (b) whether or to what extent Government should regulate any such systems, and (c) what structure should be created to provide legal definitions of responsibility for the information which would flow through such systems. While many of the most significant economic questions have been raised, critical non-economic issues have not been addressed—such as the desirability of unfettered government access to personal records either as a user or an operator of any EFT system.

Even though such basic questions continue unanswered, and often unasked, several Federal agencies have moved ahead, creating a Federal role in EFT operation. The Federal Home Loan Bank Board, the Federal Reserve Board, and the Department of the Treasury have all taken steps which move us closer to Federal operation and control of EFT systems. Yet, the proper Federal role is still an open question; perhaps most important, it is a question of such far-reaching consequence that it should be addressed and decided at the highest possible level and in the broadest possible forum. At the very least, it is not a question which should be left in the hands of a small group of agencies whose interests may not be broad enough to guarantee adequate consideration of all the issues.

The Office of Telecommunications Policy has made efforts to forestall precipitous development of a government operated or controlled EFT system. Such development should not occur without far broader and more disinterested consideration of the issues. Further, we do not think the critical choices which face us should be made in an *ad hoc* fashion by independent agencies or other departments of government, particularly when the EFT Commission is just beginning to undertake a wide-ranging examination of EFT policy. But we cannot rely on the Commission for resolution of all problems. Some choices have to be made before the Commission will speak; the private sector is moving forward rapidly and operational problems demanding immediate decision face us even now.

I hope that the accompanying study will alert all of those who ought to be concerned to the critical range of social choices which we must make in the development of a coherent Electronic Funds Transfer policy; further, I urge that all take to heart Dr. Rule's admonition that the decisions which face us are too important to be made on a piecemeal basis.

Sincerely,

John Eger, *Acting Director.*

Enclosure.

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Introduction

It is a truism that technology is a key source of change in modern, highly developed societies. As far as it goes, that statement is no more than an unexceptionable cliche. Yet the notion of technological development as an independent *cause* of social change can easily become a block to understand. For it may lead us to view scientific or technical development mistakenly as a dehumanized or desocialized force, somehow independently shaping or conditioning social relations without being influenced in return.

In fact, new technologies, and the new social arrangements which go along with them, are neither more nor less than the effects of specific social forces. Most of the applications of scientific understanding to technological change which are theoretically possible, after all, never stand a chance of being put into practice. Nor do most people ever have a chance to sponsor technological innovations. Technological change always amounts to a new way of doing things on behalf of specific social interests—on behalf of specific difficult to anticipate. Certainly the intentions of the original innovations do not simply occur of themselves, leaving "social" to accommodate as best it can. Instead, particular parties foster technological change on behalf of their own characteristic goals and interests, and often enough to the detriment of other interests.

What makes the study of technological change fascinating, and what often makes such changes seem as though endowed with will of their own, is that the long-term effects of new technologies are often difficult to anticipate. Certainly the intentions of the original innovators are no infallible guide in this respect. One doubts whether the English textile manufacturers who introduced the first automatic looms had any idea of their role in the far-reaching social, technical and economic changes which we now sweepingly designate as the industrial revolution. Once the ramifying chain of cause-and-effect relations begins, its effects may no longer lie within the control of those who set it off.

For technological change, although fueled by people's pursuit of pre-existing interests and goals, changes the terms and conditions in which this pursuit goes forward. In people's scramble to accommodate existing interests to the rules of a new game, qualitatively new social relationships come to the fore. This is especially true in that technological innovations are, by definition, matters of *technique*. The advantages and disadvantages generated by technology never accrue automatically to any one specific party, but stand to be captured by the winner among many contending parties. The mastery ocver industrial processes, which served to propel the capitalists of the English Midlands to an ascendant social position in the mid-nineteenth century, has served as well to consolidate the power base of the Soviet Communists. The long-term social effects of technological innovation stand to be determined not only by the unique qualities of the technology itself, but also by the social forces which shape its applications.

Electronic Funds Transfer, or EFT,[1] is as authenic an instance as one could wish of technical innovation with potential for far-reaching, long-term social effects. I have written this report in an attempt to anticipate some of those possible effects, especially as they bear upon such social goods as privacy, freedom and personal autonomy. For although the effects of technological change may be hard to predict, I believe that we know enough to anticipate different possible outcomes of policies which might guide the development of EFT. This is especially so in that the path of that development is not yet set, so that informed decision-making has the maximum opportunity to shape long-term social outcomes.

Personal Data and EFT

Electronic Funds Transfer is, of course, not a single entity but a *genre* of related practices. What the various applications of EFT share is the use of electronic impulses, generated and interpreted by computers, to effect debits and credits in financial accounts. The transactions included in this category run the gamut from massive transfers among banks and other financial institutions to the relatively simple recording of withdrawals made from private persons' bank or other accounts *via* automatic cash machines. Some of the better-known EFT applications are the automatic deposit of payroll and other checks to persons' bank accounts; automatic debits from such accounts for recurrent expenses such as mortgage payments; the maintenance of "automated teller" installations, remote from the account-keeping organization, where account-holders may make deposits or withdrawals; and the servicing of point-of-sale installations in retail establishments where charges otherwise paid in cash, check or credit cards are debited directly from the buyer's account.

The concerns of this report lie with the consumer applications of EFT—those entailing the transmission of data on private persons—since it is these which raise the major questions of privacy and personal autonomy. Even this subset of the broader category comprises a heterogeneous array of processes and techniques. But nearly all of them involve the working of four elements: the EFT account, the remote terminal, an identification process, and the switching mechanism.

Any organization maintaining computerized financial accounts for members of the general public could, in principle, make those accounts accessible *via* EFT. Such institutions include not only banks and thrift institutions, but also credit card firms, credit unions, department stores and others. Nor need private EFT accounts work only on a credit basis. Institutions could honor EFT charges up to a specified credit limit, on much the same plan as that followed today in credit card schemes and many checking accounts. Indeed, EFT would make such deficit accounts easier to administer, in that electronic accounting systems could prevent charges from exceeding the credit limit before those charges could even be consummated, thus making it impossible to over-extend one's credit limit. The fact that so many different institutions could offer much the same services would, as often has been noted, tend to blur the distinction in the public's mind between banks and other account-keeping organizations.

All consumer applications of EFT, with the exception of the automatic credit and debit of recurrent payments from personal accounts, require input from a remote terminal of some kind. The terminal—in effect, an on-going computer console—takes a somewhat different form in each use. Perhaps the simplest is the "cash machine," which simply reads users' account cards and transmits electronic impulses indicating that a withdrawal has taken place. Other terminals—those used in automatic teller installations or point of sale transactions—have facilities for more complicated exchange of data. These could include a keyed console, for transmitting data on the nature and amount of the transaction, some means of communicating signals to the user as to whether a transaction is authorized, and a mechanism for printing out written receipts of transactions.

Equally essential to all EFT transactions is some electronic process for identifying the account or accounts involved. In payments made between computerized accounting systems, the account number for which the payment is destined is recorded in the computer memory of the accounting system from which the payment originates. In other consumer EFT transactions, however, the EFT user wishing to activate his or her own account must provide identifying information at the time of access. The most feasible identification system available now entails the insertion of plastic cards resembling credit cards into the EFT terminal. These cards typically carry a machine-readable "magnetic stripe" which identifies the user's account with the organization issuing the card. Such cards already serve to activate the "cash machines" maintained by some banks. Future refinement of EFT technology promises eventually to make possible identification of users through electronic reading of voiceprints or fingerprints, and the automatic association of them to the corresponding accounts. Such use would obviously have the advantage of making it impossible for anyone to use stolen or other false identification.

The switching mechanism, an unseen but essential element of any but the very simplest EFT system, represents the link between remote terminals and the accounts of users. Virtually all plans for consumer-oriented EFT envisage a situation where any terminal may serve to access accounts with any account-keeping organization, and where any one user may have accounts with more than one such body. Thus the necessity for a separate computer to mediate between the impulses received at the terminal and the computer keeping the user's account. Thus the switching computer "reads" the user's identification as presented at the terminal; selects the EFT account to which it pertains; determines, if appropriate, whether the account has sufficient reserves or credit to permit the transaction; signals this determination to the user at the terminal; and debits or credits the user's account and any others involved accordingly.

The typical user-initiated EFT transaction might transpire as follows. First, the user inserts his EFT card into the terminal. Then either the user or, for transactions originating from retail establishments, a clerk uses the keyed console to tap in further data on the sought-after transaction. The switching computer then locates the account being accessed by the request, determines whether the transaction is "legitimate" under the rules governing the account, and signals the result of this inquiry to the terminal. If the transaction goes ahead, the switch debits or credits the user's account accordingly, and likewise credits any other accounts involved, such as that of the retail establishment involved in a point of sale transaction. It is likely that most EFT systems would levy a small per-transaction charge, comparable to the charge for a single check, on the use of each account.

All of these details are at least somewhat speculative, in that most EFT applications even today remain in the planning stages. Nevertheless, it is clear that any operational form of EFT would have to entail the transmission of a good deal of personal data, and that these data would have to remain "on file" for some period of time in each user's account. For a start, the record of each transaction would have to include the amount and nature of the transaction, the date, and probably also the kind of goods or services rendered, in the case of point-of-sale transactions. These data represent no more than a minimum, and it is easy to imagine other information that might be required. But without at least these facts, it would seem that any EFT system would lose the accountability for its own operations which the public would inevitably demand. Yet even this much data would obviously be volatile in its potential effects on the user.

Should consumer-oriented EFT be introduced as described here, its beguiling convenience would clearly make widespread public acceptance extremely likely. Given the proper advertising inducements, and the habituation of consumers to the use of plastic credit cards, there is every reason to think that EFT will recapitulate the explosive development of the credit card habit. This would mean the opportunity to use EFT for all sorts of transactions in all sorts of locations—in short, a world blanketed by consumer terminals. And the more numerous the users of EFT, and the larger the proportion of each consumer's transactions effected through the EFT medium, the more compelling become questions concerning the effects of technology on personal privacy and autonomy.

In the extreme case where all of everyone's consumer transactions took place through this medium, EFT accounts would become an automated, bureaucratically recorded diary of every consumer's movements and activities, as well as of his or her financial resources. The likelihood of such a prospect, of course, remains to be discussed.

No less important in implications for privacy and autonomy than the extensiveness of reliance upon EFT is the character of the communications networks developed to implement it. I have noted that the most likely form of EFT development would make any account accessible from any terminal; the alternative would be to require separate terminals for every account-keeping organization—a commercially unattractive duplication. The fact that any terminal could access any account would mean that inquiries to the system from any point could, under favorable circumstances, access account data on any account. Necessary for such access would be the number of the account containing the desired data and the proper electronic instructions to cause the computer maintaining those data to release them. The fulfillment of these conditions in any real EFT system, of course, is problematic. Nonetheless, it is significant that, if every user had but a single account, or if all accounts of the same user bore basically the same identification, an interconnecting communications system of the sort envisaged would provide opportunities for drawing together the whole of any user's account record.

Such, in their barest form, are the essential ground rules of commercial applications of Electronic Funds Transfer, and some of the potentials which have caused concern about issues such as the effects of the systems on privacy and autonomy. Yet clearly these potential effects, should EFT become an operational reality, are subject to the widest variety of interpretations. Are these potential developments serious enough to be considered grounds for concern? What concerns are the most serious, or most urgent? Is there any legitimate role for public policy in dealing with these concerns? We now turn to discussion of these questions.

Value Choices and Technical Choices

The language of policy is often far from rigorous. Even the basic notion of the "goodness" of a particular measure is subject to many different meanings. One often hears people talk about "good" legislation, policy or administration, meaning by it measures which are highly efficacious to specific, agreed-upon ends. In other contexts, people talk of the goodness of such things so as to praise the quality of the long-term ends themselves which the policy is meant to serve.

The distinction involved is roughly that between ultimate ends and intermediate ends or means. Consider an example from a topical issue well removed from Electronic Funds Transfer, that of women's rights. Much discussion of legislation and policy on this issue focuses on such questions as, "Will a particular equal-rights measure really succeed in opening new job opportunities to women?" or "Will a certain piece of legislation (or policy, or administrative ruling) entail too much red tape to be enforceable?" These are technical questions, questions about the effectiveness of specific measures or means in relation to certain sought-after ends or results. Yet in discussion of this same issue, one is also likely to hear raised, perhaps more often implicitly than explicitly, questions such as, "Is it really desirable to live in a world where women and men occupy the same social roles?" or "Is it just that the law should regulate social behavior of this kind?" These are value questions, questions of the nature of the social goods or ultimate ends which policy ought to pursue.

Any appraisal of politics and policy requires both sorts of thinking. No measure, whether it be proposed legislation, administrative policy or back-room political maneuver, is worth considering unless it appears efficacious to the ends for which it is intended; and of course much political discussion has to do with the relative promise of different measures for producing sought-after ends. At the same time, another broad category of political discussion deals with questions of ultimate value—the nature of the social goods which ought to be served by political action.

Many of the thorniest of these discussions arise in situations where the maximization of one such social good or value conflicts with that of another—e.g., individual liberty *versus* the security of the state. Clearly it is meaningless to think of pursuing any social good without a more or less efficacious technique for doing so—as meaningless as it would be to attempt to appraise the effectiveness of a technique without regard to the ends at which it was directed.

It is significant, however, that technical questions and value questions require very different steps for resolution. Strictly technical questions are ones answerable through an appeal to evidence, through an examination of "the facts"—whatever the relevant facts may be in a particular case. In other words, to test the effectiveness of a particular measure in a purely technical sense, one might gather more information about the attitudes of those who would be affected by it, or one might try it out on a limited basis and closely examine the results. Whether or not the evidence is easy to collect, this implicit evaluation of the measure by the criterion of "how it would work" marks it as a technical question.

By contrast, questions of value are not fundamentally answerable by appeal to evidence. Whether it is morally preferable to live in a world where women and men play the same social roles, or in a world where distinctions as to such roles are rigidly enforced is hardly a matter to be decided by new evidence or more intensive research. Rather, one answers such questions by examining one's own moral sensibilities—which is to say, one's own values.

There is no reason to assume the existence of a single "right answer" to such a question, since people's answers are apt to be as varied as their moral codes. In the case of the roles of men and women, there is every reason to believe that the values espoused by Americans are extremely heterogenous.

We already have a substantial literature on EFT, and on the management of personal data more generally. The bulk of these writings, it seems to me, have examined technical questions, rather than questions of social value. They have dealt with questions such as "Would it be more effective to organize EFT under a public utility, or under purely competitive, profit-making auspices?" or "What are the best procedures for preventing unauthorized access to a given category of personal records?" Discussions of EFT could begin and end with questions like these, if only the ultimate social goals or values to be sought after in these respects were matters of general agreement.

But this is not the case. For people's views on the long-term ends which the new technologies should serve, and *a fortiori* on the thorny question of what it means to protect personal privacy and freedom in conjunction with them, are very far from unanimous. What social purposes justify the collection of personal data at all? Under what circumstances is it justified to use personal information for enforcement of obligations against those to whom the data refer? When is it right to use personal data collected for one purpose in other activities which the data subject might not approve? Obviously one would not attempt to answer these questions by seeking new information or evidence; answers can come only through clarification of one's own values which may well prove to differ from those of other interested parties.

It has sometimes been a shortcoming of discussions of these matters, however, that they have treated such value questions as settled when in fact this is far from the case. Sometimes this lapse has resulted from a confusion of technical questions with value questions, as though establishing the effectiveness of a particular policy could substitute for showing the acceptability of the ends served by the policy. Thus some discussions have treated privacy as though it were the same as data security. This view would consider privacy to be protected if only "*unauthorized*" persons were *unable* to gain access to given data. But such an approach leaves open critical value questions, such as whether the data should be collected in the first place, and, if so, who ought justly to have access to them.

Indeed, the very notion of privacy is an evaluative concept. It is misleading to discuss the privacy afforded by a data system as an objective fact, like the core capacity of a computer or the number of records in a file. No concept of privacy is meaningful without some specification of the values which one supposes it to entail. We speak of the invasion of privacy, for example, as the *unwarranted* collection or examination of personal data, or as the *unjustified* intrusion of public scrutiny into certain *inappropriate* areas of personal life. Such terminology assumes some notion of what intrusions *are* justified or what collections of data *are* warranted—and these, of course, are value questions. It would be a mistake to assume that these questions are easy to resolve, or that all informed persons would resolve them in the same way.

It may be that this tendency to treat value issues associated with privacy as though they were settled and clear explains the seeming unanimity of public opinion in favor of the protection of privacy. Without some further specification of what social values are involved in such protection, the notion is virtually defined as something which everyone favors. The invasion of privacy, like government waste, politically motivated statements and irresponsibility in high places, becomes something which anyone can attack, since no one would ever defend it. The rub comes when we must specify how we would implement the social values entailed in the protection of privacy. There we are likely to find no more unanimity, say, than in our views of the proper relations between the sexes.

This report will have rather little to say about the strictly technical questions connected with EFT. It offers no arguments, for example, on the much-debated question of whether public or private auspices promise more efficient delivery of EFT switching services. It provides no new insights on whether the limitation of the establishment of EFT terminals to the immediate area of the host institution will help or hinder EFT development. Instead, what I have to say deals with questions of the social goods or values implied in the prospect of Electronic Funds Transfer. These are questions like, "Are there undesirable social consequences of EFT which call into question the wisdom of developing it at all?" "How much transfer of personal information collected via EFT for other social purposes would be justified?" "To what extent is it possible to design an EFT system which protects individual autonomy and liberty?" "How does one reckon the risks to privacy and freedom posed by EFT against the benefits which the system promises?"

It is not my purpose to take a stand in behalf of any of the value positions which this report will consider. I aim simply to persuade the reader that value questions are authentic and inescapable in Electronic Funds Transfer policy, and that not all social goods or values involved—including convenience, efficiency, privacy and personal autonomy—can simultaneously be maximized. In this respect, my purpose is the opposite of that of many writings on policy. For instead of aiming to press a single point of view against others, and thus to narrow the range of choices under consideration, this study aims to broaden debate by emphasizing fundamental conflicts involved in any policymaking in this area.

EFT as a Social Resource

To understand the role of Electronic Funds Transfer in raising issues of social value, it is helpfulto place it in the context of similar social developments. One might think of EFT as part of a broader category of what one might term "novel social resources." By this I mean innovative mechanisms for effecting some socially desired result, or more simply, new arrangements for accomplishing things that people want done.

Any reader, with a few moments reflection, can create his or her own list of novel social resources. Such innovations need not stem from technological change. Broadcasting obviously represented a novel social resource at the turn of the century, and it resulted directly from Marconi's invention; but the inception of Rural Free Delivery represented an equally authentic new social resource, and here the innovation came through legislation, not technology. The development of reliable birth control methods spelt the appearance of a new resource deriving from science and technology; but the attribution to corporations of the legal rights of persons is an instance stemming from social and legal changes rather than technical or scientific ones.

It is characteristic of the introduction of such new social resources, as I noted above, that they may promise far-reaching rearrangements in social relations, and particularly in the distribution of social interests. Yet the exact nature of such a redistribution need not be foregone at the beginning, and may not be at all predictable to those involved as observers at the time. The point is, a new means of producing something which people want, whether that something is an invention, a technique of mass persuasion, or a legal mechanism, is bound to become an object of contest among interests which would like to monopolize it. The interests which give rise to such innovations will not necessarily be the same as those which control its application at all points in the future.

One does not know for certain how the development of EFT, in any of its possible forms, might affect existing interests and social relationships in America. What is certain is that the long-term effects of such development will spell qualitative changes in social relations, rather than mere increments in existing conditions. The internal combustion engine, at the time of its first applications, provided power for transport in virtually the same contexts as the horse.

The superior possibilities of that novel resource ultimately brought about changes in social relations ranging from the human ecology of cities to styles of family structure and sexual behavior. Thus I cannot agree with the spirit of the following remarks recently offered by a spokesman for the present sponsors of EFT:

> Electronic banking is new only in method of delivering the service, not in the service itself. It is simply another step in making it more convenient and timely for our customers to use banking services.[1]

True, Electronic Funds Transfer promises to begin by offering a direct substitution for processes now accomplished by other means. But this substitution would not be attractive to anyone, unless the electronic techniques offered some powerful differences from their present-day counterparts. EFT promises the marshalling of more and more accessible personal information in the course of financial transactions. It promises to enable financial institutions to remain in constant contact with all of their customers—a category which could come to represent the entire adult population. And it promises to provide a potent new tool for the enforcement of financial obligations—and, to this extent, to offer new mechanisms for the formation of all sorts of contractual obligations. To describe the development of these potentials as new methods for delivering current services would be much like describing present-day transcontinental communications as a further elaboration of the Pony Express.

EFT as a Bureaucratic Tool

Electronic Funds Transfer, then, offers multifarious possibilities for accomplishing tasks which are either impossible today, or which can be accomplished only much less efficiently. Not all of these capabilities, nor the social interests which they will ultimately serve, are foreseeable to the present-day observer. Yet one major *genre* of EFT applications is quite predictable, and this is its use for what sociologists would term purposes of social control. Whatever other ends these systems may also serve, they will surely contribute to a pattern of growing monitoring and regulation of private person's affairs by large, bureaucratic institutions. I have attempted to deal with these processes at length in an earlier work. *Private Lives and Public Surveillance.*[2]

Characteristic of modern societies are situations in which large bureaucratic agencies must deal authoritatively with literally millions of members of the general public. Whether governmental or private, such agencies face the task of keeping track of their vast "clienteles" through systematic record-keeping, and, on occasion, using the data so maintained to enforce compliance from the persons depicted in them. Running a system of income taxation, maintaining a credit card or other consumer credit system, administering a modern system of conscription, or managing a system of life insurance—these and countless other typically modern bureaucratic operations require the shrewd and systematic administration of large amounts of personal data on the persons with whom the relevant bureaucracy deals. Using these data to prevent or punish tax fraud, to curtail bad debts, to identify and locate those legally required to serve in the armed forces, or to prevent patently bad risks from buying insurance at standard rates—these are all forms of social control.

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[1] Testimony of J. Rex Duwe on behalf of the American Bankers Association before the Subcommittee on Financial Institutions of the Senate Committee on Banking, Housing, and Urban Affairs on S. 245, "The Electronic Funds Transfer Moratorium Act," March 14, 1975.

[2] New York, Shocken Books, 1974. Some of the terminology in the following passages is explained more fully in Chapter One of that work.

On the face of things, the agencies involved in these social control operations would seem to have every advantage at their disposal. A conscription system, after all, can mobilize the authority of the state to enforce its decisions; a grantor of consumer credit can extend or withdraw credit at its own discretion. But one must remember that the numbers of persons involved are so vast that enormous resources are required merely to keep track of them all even in the most superficial way. While the power of any of these systems is awesome in relation to any single member of the public, each system must spread its power and its attentions quite widely in order to deal with everyone.

The costs, in time, attention and other resources, of tracking down and punishing just one draft-dodger or one credit delinquent can seriously detract from the efforts necessary to deal effectively with the millions which remain. And yet the stakes are high—for enormous social benefits accrue to any organization which can deal with such large numbers of people and exact some form of compliance, however modest, from them.

Clearly the efficient use of personal data is essential if bureaucracies are to succeed in these tasks. In such situations, I have argued, there are four aspects of the use of personal information which matter enormously to the viability of efforts at bureaucratic control. One is the sheer *amount* of meaningful personal data available on those with whom the system must deal. Another is the effective *centralization* of data resources, so that all available data can be brought to bear on decision-making problems wherever in the system they occur. A third is the *speed of information flow and decision-making* within the system, for speedy movement of data and quick decisions mean that the system can "react" to those with whom it deals before they can "escape." A final determinant of the effectiveness of systems like these is the *points of contact between system and clientele*, that is, the number of locations through which the system can absorb new data, and from which it can "reach out" against those on whom some corrective action is contemplated. The aggregate of these qualities I term *system capacity* for mass surveillance and control; bureaucratic record-keeping systems on persons have higher capacity to the extent that they maximize each of these dimensions.[3]

A system of the highest capacity is one which "watches" virtually everyone all of the time and which consequently has the maximum chance of shaping everyone's behaviour—an unpleasant prospect from the standpoint of some value positions, but a splended technical feat in the control of large numbers of persons.

These observations on the technique of dealing with large amounts of personal information for purposes of enforcement hold true, I would contend, quite regardless of the nature of the enforcement relationship between the system and its clientele. Whether the task is a fairly benign one of running a contributory system of public insurance, or the punitive one of tracking down criminals or political unreliables, the same organizational principles apply. Whatever the enforcement problem, in other words, any system is better off if it can deal with more data, if its data are centralized, if its information processes are more rapid, and if it maintains more rather than fewer points of contact with the public. If these qualities are virtues, they are technical virtues, not tied to the implementation of any one social value or good.

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[3] Private Lives and Public Surveillance, pp. 37–40.

Compared to present-day payment systems, there can be no question that EFT would quickly effect a distinct increase in surveillance capacity. In terms of the amount of usable personal data generated in transactions, for example, the adoption of EFT would cause many transactions to leave "'data trails" where now there are none—for example, in point of sale transactions now handled in cash.

Transactions now entailing payment by check or credit card would probably generate more data under EFT, and would certainly register those data more quickly and in a more accessible form to the institutions concerned. In terms of the centralization of data, as I have noted, the interconnecting quality of EFT systems could make it possible to access personal information on any user from any terminal within the system. This could hold true even if actual storage of data were dispersed, provided that the inquirer had access to the user's account number and could provide the proper accessing instructions to the system. This arrangement would amount effectively to total centralization of data many of which, under present circumstances, are not assembled anywhere. In terms of speed of information flow and decision-making, EFT would bring about a quantum leap over present payment systems, for transactions would register with the speed of light. By contrast, present-day check and most credit card transactions take days or even weeks to register at the institution maintaining the user's account. Today only a minority of larger credit card sales, for example, are checked against the user's account status before the transaction is complete. Finally, concerning points of contact between system and clientele, every terminal of an EFT system would represent a point of input of personal data, and a potential point for generating significant reactions to members of the EFT-using public. These processes promise quickly to become both more efficient and more widespread than their nearest equivalent today.

Bureaucratic monitoring over mass publics in America today, in the sense of these terms used here, is generally quite loose. By this I mean that many private persons' activities go unrecorded, effectively "unnoticed" by any organizational arm of the state or private industry, even when data on such activities might be extremely useful to those agencies. Selection of books at the library, registering at a hotel, presence in a particular bar or restaurant, a walk in the country, remarks made to an acquaintance in an elevator—all of these encounters can in principle generate data relevant to the concerns of some agency somewhere. But the data so generated vary vastly in the extent to which they are recorded—and, when recorded, in the extent to which they are accessible and useful for the action by organizations toward members of the public.

The prospect of the development of EFT, like that of many other systems which have appeared in recent decades, works to wear away at this looseness or anonymity. Where data on discrete, disparate individual activities have lain unrecorded or uncollected, new institutional mechanisms are growing up to tabulate such data and make them usable as bases for bureaucratic actions. At the same time that people probably face less scrutiny from family, neighbors and other individual curiosity-seekers, large institutions find new ways to turn personal data profitably to the task of monitoring relations with the persons to whom they pertain.

There is nothing about EFT which constrains the social purposes which it, like other new forms of bureaucratic monitoring of persons' activities, will serve. As presently envisaged, Electronic Funds Transfer systems would work only to monitor persons' financial affairs. But EFT mechanisms could equally well serve other social ends. In its most unpleasant manifestation, such a system could serve to store data on persons' political reliability, and to monitor their activities and movements to that same purpose. To acknowledge that such use is a possibility—however little it might accord with people's values—is hardly to suggest that it need necessarily come about. The point is simply that EFT, like other personal information systems, is a technical device, a complex tool whose only purposes are those which people attribute to it.

In sum, the introduction of EFT would entail the creation of a vigilant third party to a whole host of personal transactions. To date, many of these transactions have entailed only two parties, e.g., the private exchanges of cash between parties to retail sales. Or, the third party in the equivalent transactions today is less attenive or more remote—witness the often relatively slow response to the overextension of credit card accounts, or the after-the-fact response to the issuance of bad checks. The role of the strengthened third party in EFT transactions may simply be to ensure that the transaction proceeds according to sound financial criteria. Or that third party role could eventually become something considerably different, whether on behalf of the state or of other social interests. The question of what patterns of development of EFT ought to prevail can only be answered in terms of the social values which one feels that such systems should serve.

Some Predictable Controversies

The uses which EFT systems serve are bound to become matters of controversy. These disputes will fundamentally be value controversies, debates over the ultimate social goods most worthy of being served in EFT policy. Many of the sharpest of these disputes, though not necessarily all, will have to do with the use of EFT systems for purposes of social control. Such controversies are at least partly predictable, in that they are bound to recapitulate controversies surrounding other bureaucratic uses of personal data. Some of the contentious questions which seem bound to emerge are as follows:

1. *Is EFT in any form socially desirable?*—For a long time the collection and use of personal data was regarded as a matter of legitimate concern only to those who did the collecting. By now, however, it is widely agreed that both the subjects of data files and the public at large ought to have some say in the creation and maintenance of data banks. Official discussions in some Western European countries have entertained the idea of requiring all data banks to be licensed, with the burden of proving the necessity of creating the data store on the would-be creator. This relatively new, guarded attitude toward any collection and use of large amounts of personal data no doubt stems directly from a perception of such systems as potentially oppressive. Thus a response of one element of American public opinion to the prospect of the implementation of EFT will no doubt be that the need for such a system

does not warrant the risks entailed by compiling such large amounts of personal data in such easily transmissable form.

2. *Who is to be responsible for the safekeeping and security of EFT data?*—Any operational EFT system would necessarily entail the transmission of sensitive personal data through various organizational jurisdictions. What are the responsibilities of these various bodies in cases of "theft" of personal information? What is the responsibility, say, of institutional depositors to EFT accounts in the event that deposit data should be intercepted? The responsibility of the merchant in point-of-sale transactions? The responsibility of the agency maintaining the EFT account, and of the organization responsible for the switching system? How, in any event, can unauthorized access to EFT data be detected, and how would one single out any of these parties for responsibility in such cases?

3. *Who can exercise legitimate access to EFT data?*—This question is even thornier, if possible, than the preceding one. Any EFT system is bound to accumulate a backlog of significant account data for every account, including amounts of deposits and debits, the times of such transactions, and quite possibly data on the establishments and agencies responsible for them. These data represent an attractive resource to all sorts of interests in society. Should the courts be able to claim access to such files, as they can to written documents? Should the Internal Revenue have this right? Should welfare officials be able to make such inquiries, for example, in screening applicants for public assistance? How readily, if at all, should people be able to examine their own files? Should the organization maintaining the account have the right to disclose such data to outside commercial interests, such as credit agencies and market research firms? Issues such as these are bound to be emotional, and there will clearly be no avoiding them.

4. *What obligations should be enforceable through EFT?*—Inherent in the idea of Electronic Funds Transfer is the notion of a separate agency keeping charge of persons' financial resources. The question inevitably arises as to when such an agency should be authorized to debit the account without permission from the user. Again, should a court order suffice, and, if so, how readily should such orders be issued? Should one's EFT account be subject to automatic debits for alimony payments, for example, or for arrears in one's income tax? Should we expect to see two categories of financial obligations, e.g., "hard" commitments subject to automatic collection by debiting the EFT account, and "soft" ones still requiring some affirmative step by the EFT user? Or is there a social value entailed in requiring a voluntary step from the account holder for the discharge of all obligations?

5. *How should responsibility for EFT charges be allocated?*—Disputes over the validity of such charges are inevitable. Should EFT charges stand in the event that the consumer subsequently returns goods as faulty? Who is to make this determination? Who should be responsible for the use of stolen EFT cards? What sort of record-keeping is to be expected of the parties to EFT transactions—depositors, merchants, users and organizations maintaining the accounts—in order to verify account data in cases of disputed transactions?

These points of public controversy concerning EFT represent projections into the future, but they are not fanciful projections. On the contrary, similar controversies already take place in connection with other personal data systems. Nor should these points seem surprising in light of the discussion of EFT as a novel social resource. For the potential disputes outlined above represent inevitable conflicts over the allocation of benefits which spring from any such resource.

Some Alternative Value Positions

How are responses to controversial questions such as those cited above to be formulated? Above all, I have suggested, responses must stem from the observer's own values, the social goods which one would wish to see served by the systems. The value positions which form the bases for such responses are hardly abstruse; one hears them invoked all the time as bases for policy or political action on these and a wide variety of other subjects.

Below are brief descriptions of four of what I see as key value positions relating to the development of EFT. These four points are not scenarios or predictions of specific events, but rather broad philosophies of what good policy in this connection ought to accomplish. There is varying potential for conflict among the four positions, but I would argue that each of the four, in some form, would find a substantial share of supporters within American public opinion.

1. *A Free-Enterprise Model: Profitability the Highest Goal.*—In this view, the highest social good to be served by the development of EFT would be the profit-making potential of the firms controlling the systems. In cases of conflict between profitability and other social goods, such as users' privacy or the need of the government for data, considerations of profitability would always stand preeminent.

2. *A Statist Model: Strength and Efficiency of the State the Highest Goal.*—In this view, the most important purpose of the development of EFT would be to serve the needs of government—needs for access to personal data on citizens and needs for mechanisms of enforcement of obligations to the state. These interests would always prevail over other considerations.

3. *An Individualist or Libertarian Model: Rights and Prerogatives of the Individual User the Greatest Good.*—Under this philosophy, no development of EFT would be admissable unless it enhanced the convenience and freedom of the individual. Other social purposes that might be served by EFT, such as profitability or welfare of the state, would be sacrificed, should they conflict with the prerogatives of the individual.

4. *A Conservative Model: Curtailment of the Potential for Bureaucratic Control the Greatest Good.*—This philosophy would simply reject any development of EFT as too dangerous to personal privacy and autonomy.

I have already indicated that this report does not aim to advocate any of these value positions as against the others. The one point on which these remarks insist is that choice among these values—or, to be more exact, among contending policies which might follow from them—is inevitable in the shaping of EFT policy. For the four value positions presented above are, to varying degrees, antithetical to one another in their implications for policy.

Perhaps the one approach to the development of EFT policy, clearly incompatible with the underlying assumptions of this report, is the laissez-faire philosophy of "letting the market decide." One does hear the claim that advance assessment of policy choices like those considered here is superfluous if not actually dangerous, given the existence of market mechanisms. According to this position, the ultimate saleability of EFT as a consumer service will provide ample evidence as to whether the public accepts or rejects the implications of an EFT-oriented society. If the public finds the systems objectionable in any way, the argument goes, it will offer the severest form of censure simply by declining to support them in the market place.

The trouble with this argument is that it confuses two different kinds of decision-making. The judgments which one makes about a product or an institution in one's capacity as a consumer are no more than superficially comparable to those made as a participant in a policy debate. As a consumer of products, or institutions, or technologies, one asks, "Will this item serve the requirements of my own needs, under present conditions?" But in addressing questions of policy, either as a specialist or as a thoughtful member of the public, one asks, "How will the widespread adoption of this or that innovation by many consumers shape social conditions in general? Are the sorts of social conditions brought about by such adoption desirable, or not?"

The distinction between these two kinds of decision-making, then, is fundamental. It is the distinction between the policy decision as to whether to favor the private automobile or mass transit in developing a transportation system, on the one hand, and the personal decision whether to drive to work or to take the bus, on the other. The first kind of decision addresses the question of what sort of social world is to be sought; the second kind of decision is over how to deal in one's own right with the world as it is, like it or not.

It should not be necessary to point out that the second kind of decision cannot substitute for the first.[4] People may—and often do—accept personal options under conditions which they may wish they did not have to face. People may reconcile themselves to using their cars, for example, while wishing that an earlier policy decision had made it possible to get along without them.

The important thing is that *de facto* policy commitments may emerge from the interaction of many individual, personalistic decisions, without anyone's having planned or desired the former. When many members of the public, acting individually, decide to rely on their cars, the effect may be pollution, traffic jams, and all sorts of other joint outcomes which never figured in the thinking of those who made the personal decision, under previous conditions, to opt for private transport. No one may really desire an arms race or a war, either, but in the absence of some binding commitment on all parties, the individual pursuant of self-interest may lead to such undesired outcomes in the longer run. If we do not consider the possible longer-term outcomes of policies before committing ourselves to those policies, we will surely run the risk of having to live with undesirable outcomes which nobody opted for in the first place.

So it is with EFT. Offered a convenient shortcut to settling financial obligations, the American public is apt to respond in the same terms in which the offer is made. But such a response tells nothing about anyone's view of the desirability or undesirability of any of the collective outcomes stemming from the aggregates of these personal decisions. Without some attempt to envisage in advance what some of the most likely of these joint outcomes are, and to evaluate these possible results, we are bound eventually to confront outcomes which no one had any chance to consider in advance.

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[4] For a penetrating discussion of these and some related issues, see Mancur Olson, Jr., "The Logic of Collective Action;" Cambridge, Harvard University Press, 1965.

The balance of this report aims to do precisely these things—to imagine some of the possible long-term effects of the development of EFT, and to appraise these results in terms of values current in American political and social thinking. These value positions are to varying extents at odds with one another, and, as I have already suggested, it may be impossible to "prove" the superiority of any one over another. What is possible—and, I would hold, extremely desirable—is to render discussion more informed by enlarging understanding of the implications of possible value choices. To do this, the following pages attempt to consider each of the four positions in its pure form, and then to enquire what practical results might stem from its implementation.

By considering some effects of implementing the four positions in their most uncompromising form, we shall confront in effect their most radical implications. Therefore disclaimers are in order. The following discussion deals, for purposes of discussion and clarification, with the most extreme implications of values which few people may hold in their pure form. I certainly do not mean to suggest, in what follows, that any real businessperson would favor all of the applications of free-enterprise thinking contemplated below. Nor, for that matter, would one expect any government spokesman to defend all the possible implications of the statist model. But confronting the extreme implications of values in their pure form causes us to consider and to reconsider our feelings about those values. If one is moved to consider profitability, for example, unsatisfactory as the *only* principle to guide EFT policy, one must then face the subtle question of how to limit the use of EFT for profit-making purposes. By throwing down the gauntlet with extreme interpretations of values which many people certainly accept in more moderate form, this report should encourage people to clarify and perhaps even modify their own positions in regard to these values. But even then, there is no guarantee that the following pages will lead all readers to modify their positions in the same direction.

A Free-Enterprise Model

Profit-making firms are today among the main proponents of Electronic Funds Transfer. Their immediate plans are to generate profits by substituting electronic transactions for ones now accomplished through other means. But it is also possible to envisage much more far-reaching applications of EFT principles for profit, ones which are challenging in relation to privacy and personal autonomy.

Discussion has already noted how any EFT system is bound to generate and retain succinct and highly pertinent data on each transaction carried out by each user. It is difficult to foresee how any viable system could avoid maintaining data which would describe the date, time and nature of each transaction, the location of the user at the moment of the transaction, the identity of other parties to the transaction, and the extent of the user's financial resources. It is easy to imagine how EFT account data would also contain information on other pertinent matters, such as the user's age and place of residence.

All of these data, to put it mildly, promise many potential uses to profit-making firms.

That usefulness, it must also be remembered, increases directly the greater the dependence of the public upon EFT becomes. As more and more of the consumer's total transactions come to be mediated through the electronic system, and as more and more consumers come to be active EFT users, the richness of EFT account data for purposes of social control becomes increasingly attractive. Let us assume, simply for the sake of discussion, that dependence upon EFT were really extensive throughout the consumer population, and that complete EFT data from all persons' transactions were readily available to profit-making firms. Such assumptions are, after all, no more than consistent with the assumption of profitability as a cardinal guiding value of the system.

The data generated in such a thoroughgoing EFT system would prove enormously useful in consumer credit checking. This form of social control—control, that is, over the faithfulness with which people meet their credit obligations—suffers considerably at present from the relatively loose organization of information practices relating to credit. Data with considerable potential importance to credit decision-making, such as that on supplementary sources of income or hidden expenses such as alimony, or on court judgments or bankruptcies, are often unavailable to credit checking agencies. Such agencies strive to collect these data, but the fact that the information originates from disparate sources in sometimes unlikely locations makes it difficult to ensure completeness. Incompleteness may result in granting credit where, from the standpoint of the institution, it should not be granted, or refusing it when the complete record would warrant the opposite. Either way, the result is inefficiency in social control.

EFT records, on the other hand, could be developed into something like a complete and comprehensive history of each consumer's credit-relevant biography. If all, or nearly all, financial transcations registered *via* EFT, and if such transactions were automatically available on request to any profit-making firm, the efficiency of consumer credit decision-making would sharply increase. By making it impossible to conceal any detail of one's financial history, EFT could conduce to virtually unerring control over the extension of consumer credit.

Similarly, making the informational riches of EFT records available to market researchers could result in incredibly sophisticated and insistent advertising campaigns. Advertisers, of course, constantly strive to match the appeal to the person or group to whom it is aimed. Statistical examination of EFT files could provide very exact data on the relations between such things as income and consumption habits. Combined with other credit-related data such as family status and place of residence, such information would open the way to very exact judgments concerning the sorts of advertising to which any one person or any category of persons would be most susceptible. Sophisticated use of such data might establish for example, what category of EFT users, identifiable by name and address, show a strong likelihood of purchasing a new household appliance within the next few months. Advertisers of such products could then beam their appeals directly to this most amenable group.

Indeed, an even more sophisticated application of such techniques could tie the advertising appeal directly to the EFT point-of-sale transaction itself. Imagine a television screen and a loudspeaker connected to every point of sale computer terminal in every retail establishment imagine further that the system established a delay of, say, ninety seconds between every EFT request and the ultimate approval or disapproval of the sale. During this time a computer routine could analyze the sought-after transaction in relation to its total backlog of data on the individual, and present a televised advertisement suited precisely to the susceptibilities of the user at that specific moment. Thus a request for a purchase of an engagement ring from a young man who, according to the records, had made five similar purchases within the preceding month, could activate a discreet, televised message from a law firm dealing with breach-of-promise actions. The interpolation of the appeal at the moment of purchase could promise an unprecedented tool of persuasion.

Still another forceful use of EFT in the service of profitability might come by adapting EFT systems to use as mechanisms for enforcement of payment on credit obligations. Imagine a system in which all pay checks and other income had to be credited to electronic accounts, and where credit grantors had the prerogative of charging bad debts to the EFT account of the indebted person without the latter's consent. By removing the considerable legal and practical problems of making people pay under the present system, such an innovation would drastically reduce both bad debt losses and the expense of collections.

Since it would be impossible for customers to avoid payment, businesses would be much more willing to extend credit in all sorts of setting where credit is now problematic. The removal of possible noncompliance on the part of consumers would thus distinctly increase the ease and convenience of access to credit. Some lending institutions have already grasped this principle, in making the extension of loans conditional on the customer's agreement to an automatic "charge-off" of the monthly installment from his or her bank or credit union account.

The looseness of social control which characterizes today's payment system conduces both to certain inefficiencies and to certain protections for consumers. The inefficiencies, stemming from lack of confidence on the part of firms that checks will be honored or credit obligations met, often mean the blocking of credit processes which would otherwise go ahead. The protections to the consumer lie in his or her option not to pay—to stop payment on a check or to refuse payment on a credit obligation in dissatisfaction at some aspect of the merchant's behavior. Clearly the development of EFT could both heighten the efficiencies and remove the protections inherent in the current system. In this context, as elsewhere, the development of electronic payments systems promise a more orderly, more efficient, but also more tightly-controlled social world. Whether such a world is worth trading for the present one can only be a question of one's values.

Perhaps not even the most convinced capitalist would advocate a total end to the discretion afforded by present payment systems in regard to consumer debts. Perhaps not even the most enthusiastic advertising and marketing executive would wish to mobilize EFT data and circuitry to exploit users' most intimate predilections in the ways described above. These observations are not meant to suggest that real plans exist to these effects. They are heuristic examples—food for thought, rather than practical schemes.

The point is, if one does not accept these extreme applications, if one does not believe that the real profitability which such schemes could promise can warrant such drastic demands on privacy and autonomy, where is one to draw the line? If unlimited discretion of credit grantors to debit EFT accounts is excessive, how much discretion should there be? To what extent should any EFT user be expected to commit himself or herself in advance to allowing future debits from the account? Should firms have the right to impose such automatic debiting as a condition of doing business with anyone? If so, should the accountholder then have the right to close out that account, or to have payroll and other checks deposited elsewhere? When *should* EFT-generated data be available to outside interests such as credit reporting or market research firms? At present, account data are available for such purposes from credit card and other credit-granting firms. Should EFT data be any different? If so, what restrictions should there be on its availability, or on the uses to which the data are put, once they are made available? Should consumers have a say in the release of "their" data? If profitability is not the only consideration in these matters, what other considerations should one expect EFT policy in these connections to serve? And how is one to choose in cases of direct conflict between profitability and other contending values?

A Statist Model

Profit-making institutions are hardly the only bodies with concrete, present-day interests in the development of EFT; the Federal Reserve and the Federal Home Loan Bank Board have both acted as sponsors at the early stages. One main appeal of the development of these systems to federal agencies is the increased certainty that they would offer concerning the deposit of federal checks to private persons' accounts. By eliminating loss or theft of funds intended for such persons as federal pensioners and Social Security beneficiaries, EFT would render the work of the agencies involved distinctly more efficient.

This governmental quest for greater efficiency through greater control represents another variation on a now-familiar theme. Many similar state applications spring to mind equally readily. Just as EFT can provide certainty of the *receipt* of funds, these same processes could serve to monitor the *uses* of federally-distributed funds. For example, welfare recipients could have their accounts tagged so that point of sale payments, say, to liquor stores would be impossible. If cash withdrawals from such accounts were also blocked, such a protection could well save taxpayers many misspent dollars. Or, by the same token, comparing EFT lists of welfare recipients against other computerized lists would make it possible to identify welfare cheaters who had other sources of income. These sorts of checking, of course, are vastly easier when accomplished electronically.

Nor need the financial control afforded to the state by EFT extend only to those who, like welfare recipients, had formally relinquished the management of their own affairs. The information generated in an EFT system would provide a marvelous adjunct to the enforcement of financial obligations binding on all citizens, such as income taxation. The more EFT became the vehicle for all personal financial transactions—all payments made and received, all transfers among accounts, etc.—the easier it would be to establish liability for income tax. Indeed, total state access to EFT machinery would also greatly ease the collection of taxes, since obligations to the state could be made subject to automatic debiting.

Next, consider the problems faced by the state in contacting and identifying the countless persons wanted for some sort of administrative action. This category would include persons wanted by the police, illegal aliens, escapees from mental institutions, absconding fathers who leave dependent wives and children on public assistance, and a host of others. Such persons will energetically strive to avoid contact with the agencies which seek them. Given our present, relatively loose organization of social control in America, such efforts stand a good chance of success. Like bad check artists and poor credit risks in their relationship to business institutions, fugitives from state power may well manage to move in circles where they are not known. Intensive efforts by investigative bodies may avail in the search for any one individual whose apprehension is deemed especially important. But such extreme efforts can only take away from the total available resources for the pursuit and apprehension of others.

Yet consider the effect upon such persons of instituting a really thoroughgoing state-oriented system of EFT. This would be a system where the state would know the EFT account number of each user, and could use that number to gain immediate access to the account data. It would be a system, again, where all financial transactions had to go through EFT. Preferably fingerprints or voiceprints could serve to identify users, rather than plastic cards, so that no one could conceal his or her identity while using the system. And in such a system, agents of the state would constantly monitor the use of the EFT network, ready to swoop down upon any user who might be wanted for the settlement of obligations with any arm of the government. Under such a relentless system of state surveillance, the only way of avoiding state action would be to avoid contact with the EFT system altogether. And if all wage payments and other financial transactions worked electronically, this would be no easy matter.

One particular source of strength to a system like this would be the possibilities it would open for sharing data on persons among different state agencies. Imagine that any arm of the government with obligations to enforce from the general public would have the prerogative of "tagging" someone's EFT account. Such a designation could prevent any further use of the account until the agency had resolved its differences with the person. Thus, if someone were overdue in paying a parking ticket, he or she might find it impossible to engage in any further EFT transactions until the debt were paid. Or, persons wanted by the police could simply be "cut off" from all EFT transactions until they surrendered.

Obviously, under a system like this, the more vital needs become contingent upon EFT transactions, the more efficient any one enforcement activity becomes. The checking of passports under today's technology is relatively cumbersome, in that Immigrations officials must refer to bulky, loose-leaf volumes to determine whether the holder of a particular passport requires some special action. Under an EFT system, the account number could serve to tag persons leaving the country for enforcement of any outstanding obligations, from visa problems to alimony delinquencies to warrants for arrest. By the same token, EFT could be used to make it impossible to file one's income tax if wanted for arrest, or to purchase groceries if one's immigration visa were expired. By linking such discrete enforcement activities in a single, monolithic system of control, EFT could make a major contribution to the respect for law and order in America.

Nor should anyone think that such an application would necessarily be strictly punitive. A system like the one described here would actually make it possible to render the administration of justice more merciful, my making compliance with the law more certain. It would enable parole boards, for example, to grant parole with greater certainty that restrictions on the movements of the parolee would be adhered to. If voiceprints or fingerprints were the means of identification, and if EFT terminals were extremely widespread, a paroled individual might simply be required to "check in" to a terminal every few hours, to ensure that he did not venture away from the area where he was supposed to reside. This would be simpler and less costly than requiring such persons to present themselves to a parole officer, and above all much less burdensome for the parolee. By making social control more thorough, some would claim, one would also be making it more gentle and more just.

Again, social control in present-day America is extremely loose in relation to this fanciful extreme. Trus, there are instances of cooperation and exchange of information among enforcement agencies, as when the police check names of persons applying for or renewing their passports, or when the Immigration Service checks applications for Social Security cards. But anyone close to government enforcement activities in America will admit that there are countless instances in which the left hand simply does not know what the right is doing—and many have real difficulty in finding out. To a very large extent this looseness stems from the costs of exchanging data and coordinating enforcement activities among the agencies concerned. But it probably also results in some extent from feelings that too much centralization of enforcement powers is a bad thing in itself.

The challenging thing about sophisticated information systems like EFT is that they erode the cost constraints which countervail against the development of these powers. The long-term development of EFT would make it relatively easy and cheap to pool state enforcement activities and to tie them to a system which would monitor the daily transactions of a large proportion of the population. Whether such uses would prove generally desirable or acceptable is another matter. Excruciating questions are inevitable as to how much state use of a system founded for purely personal financial transactions is justified. Or, to put it more abstractly, how much the value of maintaining the authority of the state should guide systems like EFT, and how cases of conflict between this and other social values are to be resolved.

There can be no doubt that the choices involved would be excruciating. Imagine, for example, that an escaped murderer had announced his intention of killing again. Would the police be justified in using the person's EFT account number, assuming it were known, to trace his movements and to apprehend him? Most Americans, I presume, would have no hesitation in answering affirmatively. But what other crimes should also be included in such a mandate for state use of the

EFT system? Should such a system be used for tagging *all* persons wanted by the police? The recent resistance to participation in the FBI's National Crime Information Center suggests that some of the public would balk at this. Should the Internal Revenue have access to EFT files, to check the validity of income tax returns? Should court orders, say, for alimony payments be enforceable automatically through an EFT system, without the consent of the account holder? Should different arms of the government be able to "share" EFT enforcement capabilities, so that, for example, it would be impossible to renew one's driving license without having paid one's income tax? To answer negatively to any of these questions is to affirm a belief that the strength of the state is not the only social value to be implemented in connection with the new technology—or, to put it anoher way, to place other social values above that of a strong state. But where, then, should the limits of state influence in the workings of such systems lie?

Has anyone actually proposed any of these more thoroughgoing applications of EFT on behalf of government purposes? Not so far as I know. Again, my intent is not to lay such plans at the doorstep of anyone, but only to insist that the inception of EFT would necessarily raise these issues in due course. Given the insistence from many quarters on the most stringent possible measures to enforce any legitimate obligations to the government and to combat lawlessness, it would be rash to disregard the possibility of serious efforts on behalf of EFT applications such as these.

A Libertarian Model

Obviously the first two guiding philosophies for development of EFT have much in common. Both would entail, after all, the creation of powerful bureaucratic tools of control over the general public. A third model might differ precisely on this point—that is, in terms of the distribution of advantages between the organizational powers controlling the system and the general public of EFT users. Under this third, libertarian philosophy, no implementation of EFT would be acceptable unless it served both to enhance the convenience and to protect the autonomy of individual users.

Such a value position would of course be antipathetic to any use of EFT data for purposes other than the direct provision of EFT services. Advertising and market research, enforcement of financial and civic obligations—all these derivative uses would be an anathema to a purely individualistic philosophy. An EFT system implemented under these principles would collect and retain only the absolute minimum of personal data necessary to assure efficient financial transactions and easy verification of accounts by the user.

Discussion of the previous two models did not entertain the possibility of any "due process" guarantees to users, nor of any review process by which individual consumers might contest charges or other uses of the system which they found unacceptable. Presumably such protections to the individual could only contravene the complete ascendance of profitability or state power, and hence would not warrant consideration. But the libertarian philosophy would require elaborate means of protecting these interests through due process guarantees and processes of review. Presumably such rules would guarantee every user the fullest access to his or her own file, and provide easy channels for eradication of contested charges and rectification of other unsatisfactory practices. These guarantees would presumably also include strong penalties for access to or use of EFT-generated data by those not involved in EFT transactions.

To some extent, any liberal or individualistic philosophy for the development of EFT entails a measure of self-contradiction. The very notion of an Electronic Funds Transfer system is one of a complex, bureaucratic entity which necessarily collects and uses personal data, and in doing so imposes a measure of control over its users. Any system which did not at least prevent users from making purchases or withdrawals beyond the limit of their available deposits or credit, for example, would be so weak as no longer to remain viable as a system. Nor is it necessarily clear where the individual's interests lie with regard to the retention of accumulated personal data. Is it better, from the standpoint of the user, to collect and retain a great deal of account data, so as to facilitate resolution of disputes over charges and other transactions? Or is it preferable from the libertarian point of view to minimize the collection of such data—to eradicate it from all files as soon as possible, for example—so as to minimize the threat of its being misappropriated? In a system which of its nature imposes a measure of regimentation on individual affairs, a wholly individualistic philosophy is bound to confront some such ambiguities.

A Conservative Model

This realization that any form of EFT development would entail some measure of bureaucratic monitoring or control over the general public may lead some observers to take a fourth position—the notion that any development of these systems at all would be excessively threatening to essential social values. The implementation of this value position is by far the easiest to explain: It would simply entail the blanket prohibition of the development of EFT in all its forms.

This model is conservative in that it espouses mistrust in principle of the consequences of any centralization of control over persons' lives. No libertarian guarantees or other restrictions on the purposes served by such systems would make much difference to the exponent of this position. For he or she would argue that the potential power of the EFT machinery represents a source of unacceptable risk to privacy and liberty, even when its present operations are exemplary. Such skepticism concerning the long-term effects of centralized power, of course, has a long pedigree in political thought, especially within the conservative tradition.

Some Applications of Values in Policy

Some of the possible implications of the positions considered above have been quite fanciful, but not in the sense of idle fancy. For I would hold that even the most extreme of the possibilities considered here are no more than implementations of principles which, in their less extreme forms, many informed Americans would embrace. And contemplating the application of such principles in their extreme form, even when those applications seem outrageous, should help thoughtful people to clarify what values they would espouse in these connections, and how far such espousal should be pursued in practice. If one could not countenance the use of an EFT system for the presentation of commercial messages as contemplated above, for example, what commercial uses of EFT *would* one condone? If one holds that libertarian guarantees are an essential condition for the implementation of EFT, should those guarantees extend so far as to protect a user who is wanted for murder from detection through the system? Considering the alternative value positions in their pure form helps us confront such hard questions. And there is no doubt that actual policy-making in connection with EFT must deal with dilemmas of precisely this sort.

Most recent policies on personal data management, in other words, aim to provide some sort of mix between prerogatives to the state and those to the individual data subject, or between those of individuals and those of private data-keeping organizations, or between the rights of such organizations and those of the state. To be sure, discussion of such measures rarely identifies explicitly the social values which they embody; but the ultimate social goods which such policies aim to serve are implicit in the terms of the policy itself. Significantly, recent American thinking on these matters has shown no great consistency in terms of the social values which it has favored. Let us consider some important cases in point:

1. *The Fair Credit Reporting Act* (*1970*).—This Act represented the first major federal effort to regulate the handling of identifiable personal data. It came into being as the result of mounting public controversy over the unregulated collection, processing and sale of personal data, and over the highly influential role of such data in the outcome of credit applications. It embodies both the libertarian principles discussed above and an effort to protect the profitability of the firms comprising this industry.

The Act establishes, for example, a statute of limitations of seven to fourteen years for derogatory information held in file. It provides channels by which persons can verify the content of their own files, and some limited means for the challenge of erroneous or misleading entries. It stipulates the purposes for which credit reports may be drawn, though the purposes so specified are very broad. All in all, there are a number of attempts of varying forcefulness to guarantee some rights and prerogatives to the individual consumer in relation to the handling of data referring to him or her.

At the same time, the Fair Credit Reporting Act virtually ratifies the position of the consumer credit reporting industry to continue in its main forms of profit-making activity. It does not restrict to issuance of credit reports for any of the main purposes which had been customary in the industry, nor curtail the use of any of the main forms of personal data going into those reports. It requires credit agencies to reinvestigate data disputed by consumers, but not when the agency "has reasonable grounds to believe that the dispute by the consumer is frivolous or irrelevant." In short, the 1970 Act aims to protect the liberties of data subjects without serious curtailing the industry's processes of data management.

It is interesting that the Act also implements to some extent the second value position, concerning the role of the state. It authorizes the issuance of credit reports in response to court order, for example, and the release of important personal data from credit files to *any* government agency which requests it. What the Act definitely does not do is to put into effect any version of the fourth value position—the proscription of personal information management as a bad thing in itself. The thrust of the legislation is toward regulating, legitimating and guiding such activities, not to cutting them back.

2. *The Proposal for a National Data Center (1967).*—In 1966 a Presidential Committee headed by the distinguished economist Carl Kaysen recommended the creation of a computerized national data center. The proposed center would centralize personal information from many government agencies including the Census, the Social Security Administration and the Internal Revenue, for purposes of research and policy-making. Unlike the other three forms of record-keeping discussed here, the National Data Center was not to use any of the files for actions directed specifically to the persons concerned; instead, it was to deal with its data only in aggregate, while keeping individual files anonymous.

Controversy quickly arose over whether such a center might result in a threat to a personal privacy. Statements from both members of the Congress and Senate and interested members of the public rapidly evoked the possibility of the use of such a central data store for authoritarian and oppressive purposes. Sponsors of the measure protested that the proposed center would only deal with factual statistical data already kept by various government agencies, and insisted that excellent safeguards existed by which the privacy and anonymity of files could be preserved. Some put forward the idea that these data were safer in a single center than in their dispersed locations. Yet in the end Congress was not moved. Senator Edward Long remarked during one hearing on the matter, "Our privacy today depends on decentralization of information on individuals." [5] This was the view which prevailed in the end, and the proposal died for lack of support.

3. *Records, Computers and the Rights of Citizens; Report of the Secretary's Advisory Committee on Automated Personal Data Systems, U.S. Department of Health, Education and Welfare (July 1973).*—This Report obviously represents neither legislation nor binding policy as such. But it is worth considering here as one of the most clearly thought-out statements of position on the institutional handling of personal data.

One of the main values implicitly affirmed in this Report, as in the Fair Credit Reporting Act, is the libertarian position; many of its recommendations, in other words, aim at providing protections to the individual in connection with the management of his or her data. One of the key suggestions, for example, is "There must be no personal data record-keeping systems whose very existence is secret." [6] Other recommendations include the designation of persons responsible for the sound administration of safe-keeping of any data system; the insistence that data so kept be timely, pertinent, complete and accurate; and the limitation of conditions under which data can be transferred from one automated personal record-keeping system to another.

At the same time, many of the Report's recommendations implicitly or explicitly affirm the right of government or private institutions to maintain control over personal data for their own purposes. Thus, for example, it recommends that transfers of data without the consent of the data subject be prohibited if the destination of the data is "an automated personal data system that is not subject to these safe-guard requirements." Such a position in effect establishes transfers to other data systems as acceptable. Similarly, the Report opposes the collection of personal data which cannot be shown to be necessary; yet this requirement implicitly assumes that many routine government and private information practices are indeed "necessary" and hence deserve to continue. In fact, the "necessity" of collecting any sort of data is more a value question than a technical question, and the implicit value position here is that present circumstances justify the maintenance of a good many personal data systems. Thus, the HEW Report, like the Fair Credit Reporting Act and Privacy Act of 1974, embodies both limited guarantees to the individual concerning the use of his data and implicit assurances to state and private interests that their major activities will not be jeopardized.

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[5] Quoted in the New York Times, 15 March 1967.

[6] P. XX.

Still another value position, however, is implicit in the recommendations of the Report concerning the use of the Social Security number. Here the authors hold that consequences of further extension of such use are simply too risky to permit it:

> We take the position that a standard universal identifier (SUI) should not be established in the United States now or in the forseeable future . . .
>
> We recommend against the adoption of any nationwide, standard, personal identification format, with or without the SSN, that would enhance the likelihood of arbitrary or uncontrolled linkage of records about people.[7]

The principle behind this recommendation differs qualitatively from others embodied in the Report as discussed above. The earlier points aimed at *regulating* the collection, maintenance and transmission of personal data, whereas the recommendation concerning the Social Security number as a Standard Universal Identifier seeks to avoid the collection of potentially useful data in the first place. This latter reasoning resembles much more closely that which led to the rejection of the National Data Center. It is, of course, a manifestation of the fourth value position discussed above.

4. *The Privacy Act of 1974.*—This important piece of legislation embodies few surprises in relation to the preceding three policy positions, so far as the values which it implements are concerned. Like the Fair Credit Reporting Act transposed into the area of federal recordkeeping, it aims to guarantee certain rights and protections to the subjects of personal documentation, while affirming the legitimacy of major institutional interests in maintaining and using such records. Thus it specifies procedures by which federal agencies maintaining systems of personal records must publicize basic information about the system, including the categories of persons depicted in it and the routine uses of these records. It makes it possible for data subjects to inspect and verify the contents of their records, and to initiate proceedings to amend them in cases of dispute. It legally requires "accuracy, relevance, timeliness and completeness" of the recorded data in relation to the purposes which they are supposed to serve. It requires restriction of access to the filed data.

The obverse of all these libertarian guarantees, of course, is the corresponding guarantee to the agencies concerned that, given compliance with the law, their recordkeeping practices can continue much as usual. Nowhere does the 1974 legislation forbid the collection and use of data now regularly required by federal agencies. Rather, it requires that such agencies "maintain . . . only such information about an individual as is relevant and necessary to accomplish a purpose of the agency. . . ." Thus the purpose of the Act is not to curtail the collection and use of personal data in principle, but to provide to the individual some role in the handling of his or her own data. It represents an effort to affirm some statist and some libertarian values. But none of the conservative, anti-recordkeeping principles implied in the opposition to the National Data Center find expression in it.

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[7] xxxii–xxxiii.

Toward an EFT Policy

In the opening pages of this report I vowed not to advocate any single value position with regard to the development of EFT. I hope that readers will agree that I have stuck to my guns in this respect. Instead of trying to derive from the various policy directions discussed here a single most acceptable policy, and then arguing on behalf of that policy, I have tried to emphasize the distinctness of different positions on EFT. Instead of seeking out areas of underlying agreement in the various philosophies or orientations, I have tried to elucidate the true extent of their antipathies.

Nonetheless, discussion has made it clear that compromise is possible to varying degrees among the four main value positions discussed here, both in principle and in practice. Perhaps the form of compromise most feasible in principle is that between the statist and free-enterprise positions. For there it was apparent that the development of bureaucratic machinery for EFT on behalf of either one of those two interests would also probably facilitate its use on behalf of the other. That is, for example, a system where people use EFT as extensively as possible for commercial purposes would *ipso facto* produce more and more significant personal data, say, for use in the enforcement of income taxation. Recent legislation and policy thinking abounds in practical examples of such compromise between these two broad interests in the management of personal data systems.

We have also seen how readily practical compromises have emerged between the first two positions, on the one hand, and the libertarian position, on the other. Here the antipathy *in principle* is a bit more severe, in that the very practices which distinguish the libertarian position are often ones which curtail the prerogatives of private or state bureaucracies. But the solution in practice has been to guarantee certain delimited spheres of interest in the handling of personal data to all parties concerned. Thus, as we have noted, compromise policies of this kind may provide to data subjects some access to and control over their files, while also stipulating certain ways which state and private bureaucracies may use those data which are not necessarily desirable from the user's standpoint. Indeed, it would probably be no exaggeration to describe the bulk of legislation of this kind as given over to delimiting mutual responsibilities and prerogatives in these respects.

Not so easily compromised, however, is the fourth value position, the one holding any development of machinery for surveillance and control to be unacceptable in itself. The compromise position noted above is possible through the adjustment of the *purposes* served by bureaucratic recordkeeping, so that all parties have some control over those purposes. But it is the essence of the fourth position to downgrade the importance of the purposes served by the technology at any one point in time, in relation to the very fact of the existence of data-managing machinery. For the proponent of this position, any development of instruments of social control entails unconscionable risks for the future. Thus the most clear-cut antagonism in the development of EFT policy may be between approaches inspired by the fourth value position—ones resembling the blanket skepticism of the response to the proposed National Data Center—and approaches inspired by some combination of the first three.

Certainly there is no difficulty in imaging how to translate these two broad positions into an EFT policy. The "compromise" position, applied to EFT, would guarantee use of the technology for certain profit-making purposes and certain state purposes, while also providing circumscribed protections to the interests of individual users. It might provide means for the latter to inspect their own files, for example, and curtail uses of EFT-generated data for purposes other than financial ones. On the other hand, such a compromise policy might also assure the Internal Revenue Service and certain other government agencies access to EFT files, and might allow EFT firms to sell accumulated account data, e.g., to credit reporting agencies, without the permission of the user. Just exactly where to draw the line between individual and institutional prerogatives would be a contentious matter, but the other legislation to data shows that it could be done. On the other hand, the skeptical position, applied to EFT, would be simply to proscribe development of systems altogether.

If recent precedent is any guide, the policy ultimately guiding the response to EFT will resemble one of these two broad positions. But which should it be? Can sociological thinking or any other analysis of the matters discussed here help to designate the "right" response in this connection? In fact, I have argued that such judgments turn preponderantly on the social values of the persons who judge, and that examination of the facts of the case thus do not lead unambiguously to a single "correct" answer equally valid for all observers.

Examination of the various value positions underlying such judgments may help thoughtful observers to understand the implications of positions which they espouse, and to make decisions among the alternatives more satisfying to themselves. But in the final analysis the choice is a personal one, and there is no guarantee that elucidation of the value choices in advance is any more likely to narrow than to widen the differences among participants to these debates.

In sum, one might observe that these two broad positions differ above all in degree of optimism. The compromise position, the one favoring the development of EFT embodying certain due-process guarantees, is fundamentally distinctly optimistic. That optimism is manifest in its classically American assumption that there are no obstacles, either natural or man-made, to the quest for more bountiful way of life which good will and determined manipulation of conditions cannot overcome. Against any disadvantage or threat potentially raised by EFT to individual privacy or autonomy, it would assume, enlightened planners can create a countervailing protection or redeeming benefit. Thus no drawbacks posed by the systems would be seen as serious enough to warrant renouncing the great conveniences which they could undoubtedly provide.

The second position, the one proscribing the development of EFT in principle, is pessimistic in comparison. Proponents of this position would insist that there can be no gains of convenience provided by systems of bureaucratic management of personal data which do not entail commensurate risks. Due process guarantees and other safeguards, in this view, can never constrain absolutely the future unpleasant uses which the systems might serve.

To some extent, then, the differences between proponents of these two positions are differences in willingness to accept risks. Such differences are value differences in their classical form. Yet at the same time they are also differences in the assessment of how serious the risks of undesirable uses of these systems really are.

Thus, the optimist would insist that means are available for reducing the likelihood of misuse of EFT to very low levels. By establishing precise guidelines for who can and cannot use the systems, by creating procedures for review and outside inquiry into the working of the systems, by specifying rigidly in advance the uses which are and which are not permitted of the system—in short, by creating strong administrative protection in advance, it would be held, the risks can be made virtually negligible.

Skeptics would no doubt reply that even very small risks of very undesirable outcomes should be held unacceptable. One accepts a one-in-a-thousand risk of missing a train, for example, yet rejects an equally small risk to the safety of one's family. Similarly, the skeptic might point out, the acceptability of a risk has to do with the frequency with which it recurs. A one-in-a-thousand risk which recurs every day becomes a fifty-fifty risk over the course of more than two years. Thus the ongoing existence of systems with dangerous potentials must eventally become too threatening.

As policy-makers hammer out their positions on the future of EFT, we can no doubt expect much discussion of these risk considerations, and of the value positions with which they are interwined. I hope that these remarks will help parties to these discussions to be more self-concious about the values which they espouse, and that such awareness will make those discussions more to the point. But I should emphasize again that the effects of these remarks, even to those who finds them persuasive, will not necessarily be to foster unanimity on these questions. Indeed, if this discussion has established anything, it should be that no single "correct" policy on EFT, in the sense of one which will resolve all questions or satisfy all interests, is to be found. EFT policy may favor profitability, or state power, or individual prerogatives coupled with individual convenience, or collective freedom from risks of oppressive applications of the technology—or it may favor some combination of these things. But no policy can claim to protect all of these values equally.

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INTERCONNECTION TO COMMON-CARRIER NETWORKS

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Interconnection in the context of this paper, implies that signals in the common-carrier network enter or exit by way of non-common-carrier equipment. Federal agencies, Western Union, railroads, other right-of-way companies, local telephone companies, and the television networks were for instance, interconnected with the AT and T network long before the present controversy. In particular, the railroads' originated as telegraph, and existed before the AT and T network was formed. When problems occur, it is sometimes difficult to assign the responsibility, but the two interconnected parties are basically cooperative. Formerly, there were many places served by two telephone companies. Some were fully competitive, some were partly overlapping in area, and some were specialized business or municipal services. Because of the inconvenience and expense of interconnecting calls, competing systems have usually disappeared. Where overlap continues, telephone users are dissatisfied. Efficiency seems to require that telephone service be a monopoly.

From the 1920's until recently, interconnection was allowed only with the permission of the telephone company. Interconnection has become a controversial public policy issue because two FCC decisions have allowed interconnection in competition with the traditional common-carriers. The competition is not in providing rival local telephone networks, but in two other areas, namely, specialized communication services and privately owned terminal equipment.

In 1967 the FCC made the famous Carterfone decision. The Carterfone was an acoustic and inductively coupled device designed to interconnect a private mobile radio system to the telephone network. The telephone handset was placed into the Carterfone cradle, allowing two-way communication over a combined radio and telephone link. There was opposition to the Carterfone by AT and T on the basis of tariff provisions prohibiting interconnection, and it was claimed that indiscriminate interconnection would compromise the reliability and dependability of service. The FCC decided in favor of Carter; the tariff provision forbidding interconnection was ruled invalid because it contained a blanket prohibition on harmless as well as harmful devices. This opened the way for other manufacturers to provide terminal equipment.

In compliance with the FCC decision, AT&T filed revised tariffs which specify key signal characteristics and require the use of telephone company-provided interconnecting devices as a buffer between customer-owned equipment and the network. These technical standards are still important in the interconnection question. Equipment suppliers resist the interconnecting devices, claiming that their purpose is to impede interconnections and that they add an extra cost not levied on Bell equipment.

In 1969, the FCC granted Microwave Communications, Inc. (MCI) permission to construct a microwave system for limited common carrier private line service, ending the monopoly at AT&T long lines. MCI was formed because it was claimed that AT&T's rates were higher than justified by costs, especially on high volume routes. This was not disputed by AT&T but justified by them on the grounds of their policy of "value of service" pricing which reflects nationwide average costs. Since the FCC approves the rates, regulated monopoly has been replaced by regulated competition. There have been at least a dozen other applications to form specialized common carriers. While it is possible for specialized common carriers to provide a complete link, some depend on local telephone companies for local loops. AT&T has been ordered by the FCC to allow MCI to interconnect to local networks on the same basis as AT&T long lines, and MCI is suing to hasten AT&T's compliance. Voluminuos standards already exist for this type of interconnection.

In 1969, after AT&T's interconnection tariff was filed, the Common Carrier Bureau of the FCC asked the NAS to perform a technical analysis of the interconnection problem. A panel was formed, of senior people from industry, government, universities, and the Bell system. More than 50 papers were submitted, including several from AT&T. The panel reached these conclusions:

1. Uncontrolled interconnection can harm personnel, network performance and property.
2. The signal specifications are technically based and valid, and exceeding them can cause harm.
3. The tariff specifications and connecting arrangements assure protection.

These conclusions—and the extensive supporting discussions—are in agreement with AT&T's submissions and replies to the panel. These conclusions are quite reasonable, but they generate obvious questions. What control is required? How much harm is caused by exceeding the specifications? Can protection be assured without connecting arrangements? The NAS report considered if connecting arrangements could be avoided, and concluded that

4. The present tariffs with "a properly authorized and enforced program of standards development, equipment authorization, equipment certification, and controlled installation and maintenance are an acceptable basis of achieving direct user interconnection."

Acting on this, the FCC established advisory committees to develop standards and procedures for each type of terminal device. Satisfying the standards seems more difficult than using connecting arrangements. For example, the first committee to report delivered a 366 page report on Barrier PBX's. Defining the interface takes 58 pages. There are 159 pages describing certification tests and inspection, 47 pages for on-site test and inspection, 30 pages on procedures and enforcement, and 44 pages of largely dissenting comments of committee members.

At the University of Pennsylvania some of our work on an NSF grant has been aimed at investigating the possible harms of interconnection. Four harms were listed in the NAS report: a) voltages dangerous to human life, b) signals of excessive amplitude or spectrum, c) improper line balance, d) improper control signals. We have considered the likelihood of these harms, the way harm is caused, the incentives for equipment manufacturers and users to cause or avoid harms, and ways to prevent harms.

The present approach is to strongly prevent harm by a combination of signal specifications and connecting arrangements. AT&T gains little from interconnection, and prefers not to accept any risk of harm. The cost of a connecting arrangement, typically $5.00 per month, is paid by the interconnecting customer. These costs total more than $20 million per year, assuming 400,000 connecting arrangements. For consumer interconnect equipment, coupler costs usually equal equipment costs. This discourages interconnection, or causes interconnection to be done illegally.

For Western Electric (AT&T) equipment, connecting arrangements are not required, and their functions are not duplicated. AT&T designs for safety, reliability, and performance, and justly considers its standards superior to those of the consumer electronics industry.

A program of standards, enforced by the FCC on all interconnect manufacturers, could prevent harm at less cost than connecting arrangements, and would also prevent harm due to illegal interconnection. A Bell testing program, lasting 4 years and covering more than 4 million residential telephones, found a 1.5% incidence of unauthorized extensions. Since there are 130 million telephones, illegal interconnection probably exceeds legal interconnection. Illegal interconnection escapes the present controls.

As mentioned before, standards to prevent harm were proposed by the NAS panel and prepared by several FCC advisory committees. These standards are elaborate, particularly concerning control signals, and they are not especially preferable to connecting arrangements. The cost of these standards, certifications, tests, and controls, which AT&T will not be required to meet, may far exceed the cost of connecting arrangements. The protection from improper control signals given by these standards is better than the protection given by connecting arrangements, which do not correct dial pulse timing.

There seems to be no reason for requiring interconnect manufacturers to meet more difficult standards than Western Electric does; this would impede competition. Furthermore, specifications are needed only when poor engineering, or deliberate violation of the tariff specifications, can cause harm to the common-carrier system, without significantly harming the interconnector. If poor design causes difficulty for the user of interconnected equipment, he will correct the problem. When harming the network means poor performance, standards are self-enforcing.

We consider each of the four harms.

The most important harm is the first, voltages dangerous to human life. There is concern that high voltages, especially 117 VAC power, may be connected to local loops. Such failures have occurred, but no fatalities have resulted. Dangerous voltages are prevented by a saturating transformer and by varactor limiters in the connecting arrangement. The Dialer Advisory Subcommittee's report specifies that no power sources shall be connected to the network, and requires a leakage current test on these samples.

It is not easy to define a dangerous voltage. Harmful effects are determined by the amount of current passing through the body. The lowest body resistance is 1,000 ohms, and the accepted maximum harmless current is 5mA, which is above the threshold of perception. Injury can occur at 15mA, due to muscular contraction, and death from ventricular fibrillation (disorganized heart pumping) can occur at 100mA. A few hundred micro-Amperes flowing through heart tissue can cause fibrillation, so that the current path through the body is important. It follows that 5 volts is harmless, 15 volts can cause injury, and 100 volts can cause death. High skin resistance and involuntary muscle contractions, which jerk a person away from the voltage source, often prevent injury, even for much higher voltages. It is sometimes claimed that the heart is most sensitive to power line frequencies, 50 to 60 Hertz, but heart response is similar for DC and low frequency AC.

AT&T typically uses a 48VAC voice power supply, and superimposes 96VAC at 20Hz for ringing. Teletype lines use 200 VDC at 60mA. The metallic conductor specifications limit AC to 70.7V peak to ground and limit DC to 135V to ground. Current is limited by fuses and resistors to one Ampere. Operating current may be 350mA. Telephone company voltages meet the specifications because telephone local loops are wire pairs, balanced to ground. 100V RMS AC and 270 VDC are allowed. These voltages are potentially lethal, even though no fatalities have been due to telephone company voltages. Hands on contact with such voltages should be avoided.

House power is 117V RMS to ground. Current is fused at 15 to 30 Amperes, enough to cause respiratory paralysis and burns. This voltage can be imposed on a local loop by an equipment failure. Power and voice wires may be pinched together, a wire may short to a terminal, or circuit components may become shorted. These failures often have high impedance and low current capacity.

Injury due to a dangerous voltage derived from customer provided equipment can result only (1) if the customer provided equipment has a failure causing a low impedance contact between the power line and the telephone loop, (2) if the equipment continues to operate normally, and (3) if a repairman accidentally touches the loop. While this is unlikely, more is needed than a prohibition on connecting power to the telephone wires. Following Western Electric practice, interconnect equipment manufacturers should be required to separate the telephone lines from power lines and circuits and to meet AT&T's restrictions on operating voltage and current given above. Competitive pressures force manufacturers to cut corners, but poor design should not be allowed to compromise safety.

The second harm is signals of excessive amplitude or improper spectrum. There are two specifications on signal power. Loop input power must be less than OdBm to avoid local loop cable cross-talk. Central office power must be less than —12dBm to avoid overloading long distance repeater amplifiers, which also causes cross-talk.

Local loop cross-talk is due to capacitive coupling between different pairs in a cable. Equal voltages are induced in a balanced pair, and these cancel at the loop termination. Cables are twisted and alternated in position to reduce coupling, and the typical loss between pairs in a cable is 100dB, with 99% better than 80dB. The contribution of each disturbing pair is so small that cross-talk is usually observed as a noise-like signal, due to many disturbing pair. For example, if coupling loss is 100dB for a cable of 1,000 pairs powered at 0dBm, there is a cross talk noise of −100+30 or −70dBm. Only very high power signals could overcome the 80 or 100dB loss and produce intelligible cross-talk and it would require a substantial increase in average power to increase noise to a noticeable level.

The −12dBm specification at the central office is more serious. Since loop loss is typically 3 to 5dB, this specification is usually the tightest. As power is increased, repeater amplifiers become nonlinear, and intermodulation products are generated. Repeaters are designed to minimize intermodulation, with the requirement that intermodulation noise not exceed thermal noise at −16dBm average channel power. (−16dBm, allowing 3dB because only one direction of a two way channel is used at a time, and allowing 1dB loss from the test point to the repeater, gives a −12dBm requirement.) −16dBm power is then optimum power because less power gives a lower ratio of signal power to thermal noise and more power will increase intermodulation noise. The actual amplifier characteristics are important. Human voice peaks are 10 or 12dB above average power, and the fraction of repeater channels used varies greatly. The TD–3 microwave repeater has peak power 11.2dB above the −16dBm average per channel or −4.8dBm. The signal is FM, so that increased signal power does not increase transmitted power or distortion. The N–3 cable carrier repeater compresses the input signal. This generates the same intermodulation noise for a wide range of input power. For higher input power, gain is reduced. In the TD–3 and N–3 systems, increased signal power does not increase intermodulation noise. The L4 coaxial repeater is a standard amplifier, designed for low intermodulation. The modulation coefficient of the best design varies less than .2dB for signal power between −18 dBm and −14 dBm per voice channel. In the L4 system, intermodulation noise power increases as many dB as the total signal power increases, at least for power less than −13dBm. At some higher input power the intermodulation may increase faster than input power.

Both for cable cross-talk and for intermodulation noise in standard amplifiers, the cross-talk noise power increases the same amount as total signal power increases. For example, if half the channels have twice the allowed power (3dB more) while the rest have the allowed power, total power is 1.5 times larger (+1.8dB) and so is the intermodulation and cross-talk noise. If one per cent of the channels have ten times the allowed power (+10dB), total power is 1.09 times larger (+0.38dB). If one user increases power, his signal-to-noise ratio increases, but other users will have increased noise and decreased signal-to-noise ratio. It is important to control power levels to prevent this, but only average power must be controlled.

The average telephone signal-to-noise is 35dB for long distance, and up to 42dB for short links. Bell system noise measurements show that signal-to-noise has a normal distribution in dB. Standard deviations are 3.8dB (5.8 times) for long distance and 13dB (200 times) for short links. 32%, or nearly one-third of all links, will have signal-to-noise ratio more than one standard deviation above or below the average signal-to-noise ratio. There is a large variation in circuit quality. For the best circuits noise is inaudible, and twice the noise power would still be inaudible. If the noise is several dB above the threshold of perception, the minimum perceptable increase in amplitude is a doubling of noise power (+3dB); no smaller increase can be identified. If signal-to-noise ratio is poor, 12dB, only 90% of the words spoken will be correctly identified. If noise power is doubled, 82% of the words will still be correctly identified. A noise increase of less than 3dB would not be noticed by telephone users, and Bell system surveys do not determine average noise power any closer than plus or minus 3dB.

The −12dBm specification applies at the central office. A 4dB typical loop attenuation can be allowed, so average input power should not exceed −8dBm. If power is controlled by loop length, as in standard telephones, equipment on longer loops can use more power. Interconnect manufacturers should be required to design equipment for −12dBm or less nominal power at the central office, and be required to use sufficient control to insure that the average power at the central office will not exceed −12dBm by more than 3dB. The second requirement is easily met, even when many inputs have double the nominal power. This specification is meant to apply to terminal equipment sold over the counter, for connection to the switched network. For data modems used on private lines, the standard interface power is 0dBm. Private line equipment does not have dialing capability, so using it on the switched network requires a telephone and coupling arrangement.

The second harm also includes signals of improper spectrum. Bell is concerned that signals having significant power at frequencies above 4,000Hz will be used, causing harm. Coupling arrangements do not protect against this harm. Human voice power is at least 20dB below 500Hz power at these frequencies, so that equipment for voice transmission is unlikely to cause harm. There are several specifications. Power between 3,995 and 4,005Hz must be 18dB below in-band power, to avoid interference with the 4,000Hz N3 carrier. Even if most of the signal power were in this band, the loop attenuation at 4,000Hz would insure that this specification was met. Power between 4KHz and 10KHz must be less than −16dBm, to avoid adding cross-talk noise to FM program material. The supporting calculation, in the NAS report and Bell's submission to the NAS, shows that the disturbing power in the entire audio spectrum, not only 4 to 10KHz, should be less than −16dBm; this is the maximum specified power. As long as the power in the 4 to 10KHz band does not exceed the maximum allowed power, this specification is met.

There are more limitations on out-of-band power, based on the requirements of the U–1 carrier and Picturephone systems. The U–1 never entered production and Picturephone is restricted to a few experimental areas. There are other Bell subscriber loop carrier systems which use high frequencies, but interference with these systems by voice band terminal equipment is unlikely. Most interference would be from similar systems using the same frequencies. No cases of customer equipment causing harm due to out-of-band power are known. There is no need to control out-of-band power. The local loop can carry signals up to 1MHz, although with large attenuation. Bell is concerned that users will exploit this spectrum, using systems similar to Bell's subscriber loop carrier, while paying only for voice band service.

The third harm is improper line balance. If the wire pair is not balanced, cross-talk coupling increases. The coupling arrangement transformer corrects unbalance. Grounding one conductor of a pair increases coupling by 20dB to a normal pair. If two wire pairs each have a grounded wire, coupling increases as much as 60dB. The effect of increased coupling is similar to the effect of increased power. A grounded termination causes a noise level equal to that of a balanced terminal with 20dB (100 times) more power. If there are hundreds of wire pairs in a cable, and only one is grounded, the noise increase is negligible. However, coupling is due to capacitance between the wires, and works both ways. The pair with a grounded termination will receive 20dB more cross-talk noise from all other pairs. In addition, if there is more than one grounded termination, coupling between such pairs increases 60dB. Unbalanced customer provided equipment will have very poor signal-to-noise ratio, even when not causing detectable harm. Poorly designed, accidentally grounded, or failed equipment that is unbalanced to ground will be repaired or replaced. Although a balanced termination is desirable, a specification requiring a balanced termination is not necessary.

The fourth and final harm is improper control signals. The ordinary telephone is required to provide an on-hook/off-hook signal, which indicate when the receiver is lifted, and dial pulse contacts or touch-tone signals which control switching. Wrong numbers waste operating time and annoy users. Connecting arrangements that don't use standard telephones to do network signaling, use a relay to repeat the dial pulses. Improper timing is not corrected, even though it causes wrong numbers. The NAS report characterized the protection provided as minimal, and observed that experienced companies build control signal equipment as good as Bell's.

A 2,600Hz single frequency is used to indicate a circuit is not in use. If the power in the 2,450 to 2,750Hz band exceeds the power in the 800 to 2,450Hz band, the network may mistakenly respond to 2,600Hz and break the connection. Mistaken detection of this signal in known as talk-off, and sometimes occurs with a human voice and Bell equipment.

Improper network control signals of these types (on-hook, dial pulse, or 2,600Hz) will interfere with normal use of customer provided equipment, and will be obvious to the operator, who can be expected to take corrective action. For this reason, specifications on network control signalling are not necessary.

Our conclusions are:

(1) A uniform specification on manufacturers would prevent harm, especially harm due to illegal interconnection.

(2) Specifications are required only to reduce the possibility of power line crosses, to limit operating voltage and current, and to limit average power.

(3) Signals having power above 4KHz cause no technical harm.

(4) Line unbalance and improper network control signals are much more harmful to the user than to the network, and do not require control.

SHOULD GOVERNMENT BE INVOLVED IN TELECOMMUNICATIONS?

By Peter C. Goldmark, President, Goldmark Communications Corporation, and Director of the "New Rural Society Project"

I am Peter Goldmark, President and Director of Research of Goldmark Communications Corporation, Stamford, Connecticut. My previous affiliation has been with the Columbia Broadcasting System, Inc., where I served as President of CBS Laboratories. I welcome this opportunity to submit a statement to this distinguished committee and express my views on telecommunications research and policy development.

Except during the last 60 odd years, all during recorded history, people on earth existed without telecommunications.

Because of radical changes we have created in the world around us as a result of the rapid development of science and technology, including telecommunications, it will be increasingly difficult for governments to function effectively without frequent and sometimes radical revision of systems and regulations, which were still adequate at the start of this Century, but not so toward the end.

Before Sputnik, space technology in the USA was almost nonexistent. Only the government could plan and execute a program of such giant proportions, entrusted to the newly created NASA. Worldwide satellite communications was one outcome of this huge undertaking, which private industry never would and never could have initiated.

But the job for satellite communications has only begun. For instance, one-quarter of this country's population has either no or inadequate access to the entertainment, cultural and educational offerings available to urban and suburban residents through broadcast TV and live stage performances.

Our major concerns are now the urban, rural and energy problems, which are interdependent. Making rural America attractive to more people as a place to live and work, should help to redistribute population, based on free choice. In the early 1930's, when electric power was becoming a necessity for rural homes and farms, the Rural Electrification Administration was created. Today, telecommunication has become another such common need.

During last year's study of the Communications Panel of the National Research Council on behalf of NASA "On practical applications of space systems," an important case in point was recommended for consideration. This had to do with a satellite system to provide TV and cultural and educational programs to all rural areas, including farms, in the U.S.

The Study Panel felt that indeed the full range of informational, educational, and entertainment programs could be delivered electronically to our 50 million rural residents, but that Cable TV systems could only provide adequate transmission capacity in rural America at a very high investment, since it is required to serve vast areas of low population density.

To fulfill the need of making rural America attractive for more people and to deliver to their homes, in addition to the entertainment and public affairs offerings on national TV, vocational, continuing and health education as well as regional and community information, the Panel offered a concept of a synchronous communications satellite system consisting of two identical satellites, both with fourteen 40 MHz TV transponders each with 100 watts output. Typically, the total of 28 transponders can be utilized as follows: On Satellite I, three 400 watt high-power signals are produced by combining four output stages for each of three national TV channels corresponding to the commercial networks. These three TV signals, each 40 MHz wide, are fed to the same antenna, covering the entire U.S. Two more channels on the same satellite serve regions I and II, approximately corresponding to Time Zones I and II, counting from the West. Satellite II has two national broadcast channels, again each combining the output from four 100 watt transmitters. One of these channels could be assigned to the Public Broadcast Service and the other to cable networking or for educational and health care services. Of the remaining 100 watt transmitters, two would serve Time Zone III and four would broadcast to Time Zone IV (East Coast of the U.S.) This makes it possible on the average for six states to share one transponder. Thus, within a given region or time zone, each state can have one-sixth share of the broadcast day to transmit pertinent local or regional information which can be received everywhere within the zone. Each satellite would have two antennas, the smaller one taking the broadcast feeds covering the entire nation, and the large antenna serving the individual zones.

Figures I and II illustrate the above and also the number of 40 MHz channels transmitted by the two satellites numbered F_1 through F_{12}. The twelfth 40 MHz channel, namely F_6, is reserved to be combined with F_5 providing an 80 MHz wide special broadcast channel for the high-resolution color TV signal for theater projection.

Regarding reception, it is estimated that a two-meter antenna together with a 250° receiver and using a parametric amplifier at room temperature, will provide commercially acceptable pictures anywhere in the U.S. It was estimated that this equipment, in the large quantities involved, represents a single expenditure per house of under $500.

The proposed rural satellite TV service (Rural-Sat), in addition to a broadcast TV service, could enable rural areas and communities to share in the cultural and entertainment events now available in metropolitan centers. Live performances of drama, opera, concerts, ballet, museum visits, lectures, meetings, sports events, conventions, and other offerings could be beamed to the rural TV geostationary satellite, which in turn would rebroadcast these programs, live, over the entire country. The program could be shown on large-screen, high-resolution, TV projectors in existing auditoriums or theaters.

The Panel believes that, with modest admission charges at TV theaters and modest charges per program to cable TV subscribers, several hundred ground installations could make an operation system profitable. Moreover, the program sources, such as opera, ballet, concerts, etc., which now barely exist on charitable contributions, may become economically solvent.

The "Rural-Sat" system just discussed, and which has been presented to the Office of Technology Assessment in considerable detail earlier this year, is essential to the current and future wellbeing of the Nation, for the reasons stated earlier. It would be unreasonable to expect for private industry to undertake the development, although it may wish to underwrite the operation, once launched. As a matter of fact, economic analyses made show that it would be a profitable venture and that the government could be easily reimbursed over a reasonably short period of time for the development and launching costs.

NASA would be the agency, where this activity should take place in view of its vast background experience and skill in satellite systems management.

It is hoped that legislation can be generated, enabling this Nation to utilize its human, its land and its energy resources in an optimal fashion and that the telecommunication needs for this purpose will be met promptly and effectively.

①

Oct 27 '74

Five national channels { 3. . . . Comm. Network
1. . . . PBS.
1. . . . Cable Network

One of these, F5, can be expanded by addition of another channel, F6 for use of high resolution color transmission (large screen)

Satellite I

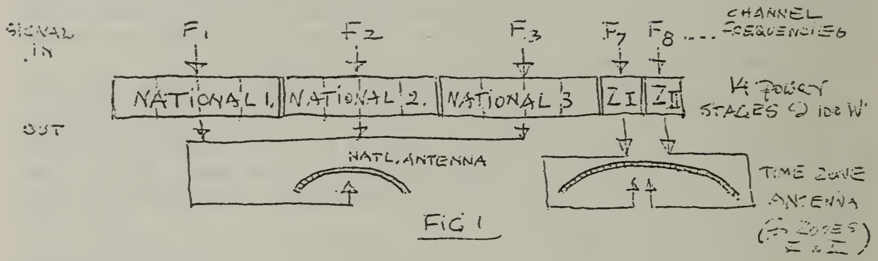


FIG 1

SATELLITE II

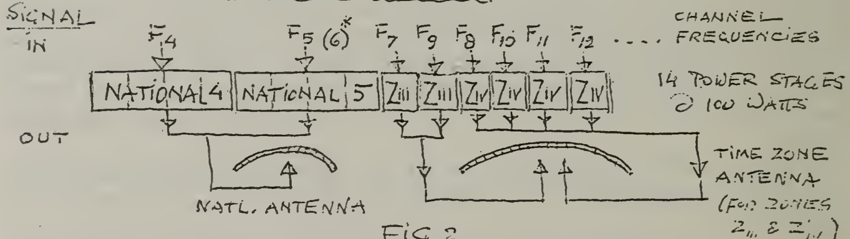

SIGNAL IN
F4
F5 (6)*
F7
F9
F8
F10
F11
F12 . . . . CHANNEL FREQUENCIES
NATIONAL 4
NATIONAL 5
ZIII
ZIII
ZIV
ZIV
ZIV
ZIV
14 POWER STAGES @ 100 WATTS
OUT
TIME ZONE ANTENNA (FOR ZONES ZIII & ZIV)
NATL. ANTENNA

FIG 2

SATELLITE I: 3 NATL. CHANNELS @ 400 W EACH PLUS 2 TIME ZONE CHANNELS @ 100 W EACH
TOTAL 1400 W

SATELLITE II: 2 NATL. CHANNELS @ 400 W EACH PLUS 6 TIME ZONE CHANNELS @ 100 W EACH
TOTAL 1400 W

* Add another channel (6) for high resolution color (80 MH DEVIATION)

STATEMENT OF LYNN W. ELLIS, DIRECTOR, TELECOMMUNICATIONS, ITT TECHNICAL DEPARTMENT, NEW YORK CITY

My name is Lynn W. Ellis. I reside at Westport, Connecticut. I am Director, Telecommunications, ITT Technical Department, New York City.

I attended Cornell University, earning the degree of Bachelor of Electrical Engineering in 1948. Following a number of years of part-time graduate study, while employed, I attained the degree of Master of Science in 1954 from Stevens Institute of Technology, and subsequently engaged in additional graduate study at the New York University School of Business Administration.

From 1948 to 1955, I was employed in various engineering positions up to project engineer in ITT's Federal Telecommunications Laboratories (now Defense Communication Division) in Nutley, New Jersey, with the exception of a period for military service as a Lieutenant in the Signal Corps. In 1955 I was transferred to ITT's International Standard Electric Corporation for systems engineering management position including three years in Spain, and three years in the Transmission Division of ITT's affiliate, Standard Telephones and Cables Ltd., in London, England, and a further year in Spain.

In 1962 I was transferred to ITT's Standard Telephones and Cables (Pty.) Ltd. in Sidney, Australia, initially as Chief Transmission Engineer, and successively, Deputy Manager, Transmission Division; Manager, Radio Division; and Assistant Managing Director with responsibilities for the manufacture of telecommunications equipment and electronic components.

Returning to ITT Headquarters in 1966, I was assigned responsibilities as Technical Director, Transmission Systems for guiding ITT's Research, Development and Engineering (R. D. & E.) in wire transmission systems, radio and microwave transmission systems; and communications and power cables. In my current position as Director-Telecommunications I continue the above responsibilities and also am responsible for R. D. & E. in computers, teleprinters, data peripherals, computer aids to design, postal automation, and railway signalling. During the past 9 years I have also for various intervals held responsibilities for remote control systems, engineering standardization, industrial design, and telecommunications planning. I am President of ITT's subsidiary, Intelplan, Inc., which has conducted contract studies on telecommunications planning for telephone administrations in Latin America.

In 1973 I was elected a Fellow of the Institute of Electrical and Electronic Engineers. Following service on the National Academy of Engineering's Panels on Urban Communications (as an adviser) and on Telecommunications Research (as a member), I was designated in 1973 and currently serve as a member of that Academy's Committee on Telecommunications, which has subsequently been organizationally transferred under the Assembly of Engineering of the National Research Council.

ITT's Overall R.D.E. Program

Research, Development and Engineering (R. D. E.) in ITT is divided into Research and Development (R. & D.), representing internally funded investigations, studies, and product and process development; customer contract engineering, representing studies and development (principally of military products) which are paid for directly by a customer; customer design and application engineering representing costs applicable to specific hardware contracts which are charged to cost of sales; and engineering assistance to marketing and manufacturing which is paid for by those departments. The ITT Headquarters Technical function is charged with central control and supervision of R. & D. throughout the ITT System, and for monitoring and aiding in the effective exercise of the other functions which are controlled and supervised on a decentralized basis.

ITT Exhibit 16, annexed to my testimony, represents the trends and absolute values of R. D. & E. and R. & D. in ITT over a 10 year period from 1966 to1975 (1966 to 1973 actual costs, 1974 and 1975 budgeted costs). During this period ITT acquired certain affiliates which provide various consumer services, so a more meaningful comparison is shown in ITT Exhibit 17 representing the R.D. & E. and R. & D. costs related to total manufacturing sales of ITT. These curves reflect a changing product mix in ITT between the telecommunications and other manufactured products, and a conscious effort to shift the technical resources towards more R. & D. by improving engineering effectiveness, as shown in ITT Exhibit 18. By 1974 the R. & D. percentage had reached half of total R. D. & E., insuring a steady flow of new products to the market place.

ITT Exhibits 20 and 21 show, respectively, the division of R. D. & E. and R. & D. between the operating groups and areas of ITT. Telecommunications, R. & D. is concentrated in the Europe, N.A. Telecommunications, Latin America and Far East & Pacific groups which include also some other product lines. The dominant R. & D. expenditure of ITT in Europe is a direct consequence of acces to markets on that continent, although as a percentage of sales R. & D. in North American Telecommunications is actually slightly higher.

ITT's Telecommunications R. D. & E. Program-Worldwide

Under existing intercompany arrangements applicable to telecommunications, the R. D. & E. done in one area is available freely to companies in other areas, providing the receiving company recompenses the originating company for out-of-pocket expenses involved in the transfer. In the case of a product in manufacture this may be as little as the cost of reproduction of manufacturing drawings if they are comprehensive. In some cases where sketches were used by the originating company rather than full drawings, or where local adaptations are required by the receiving company, these charges have been extensive, and have also involved the physical transfer of technical staff during the start up phase, as will be described in a specific example later in this testimony. Because of the pace of competition, it may not be possible to wait until the originating company has completed manufacturing darwings, and proved them in production, and often transfer takes place in a fragmentary manner from laboratory information. Virtually all of the telecommunications manufacturing operations have at one time or another used these different methods of obtaining such information from divisions in other countries.

ITT's Research and Advanced Development program in telecommunications is carried out at four central laboratories in:

Harlow, Essex, United Kingdom;
Velizy, France;
Madrid, Spain; and
Stuttgart, West Germany.

Product development in telecommunications is carried out in many manufacuring locations in developed countries, including the U.S., Canada, U.K., France, Spain, West Germany, Switzerland, Austria, Italy, Belgium, Netherlands, Denmark, Norway, Sweden, Brazil, South Africa, and Australia. In a number of other countries there is some local adaptive and applications engineering capability.

A breakdown is given in ITT Exhibit 22 showing total engineering personnel and R. D. & E. for 1972 by major industry groups. Of the total of 19,098 engineering people about 70% represented engineers and scientists and the balance technicians, draftsmen and miscellaneous technical support personnel.

Many of the telecommunications administrations in these developed countries have strong ideas on product development and features. In some countries, such as the U.K. and France, organized consortia or committees exist to harmonize the designs of national manufacturers under the supervision of the telephone administration which is itself a government entity. In other countries less formal administration control of product development exists (such as specifying only test access arrangements and equipment dimensions), and in some developed countries, and in most of the less developed countries, the choice is left to the manufacture as to how he develops his product.

To cope with the diversity, research and advanced development is usually conducted on a non-national basis either against internationally specified requirements, or against an internally generated (by ITT) International Functional Specification (IFS). Almost always this design is carried through to an ITT standard product which is offered for export in those countries with less formal requirements. Where a product is low volume, one country's national standard may be adopted as ITT standard rather than undergo the expense of having two versions.

In those countries with very formal standards, where ITT has sufficient market access, a national standard product will be developed separately, or adapted in whole or part from the ITT standard product. Examples of national standard products developed separately include the TE-400A electronic PABX in the U.S., the TXE-4 electronic telephone switching system in the U.K., mechanical filter frequency division multiplex in West Germany, and high power 11GHz microwave radio links in Switzerland. An example of a national standard system adapted from an ITT standard system is the T124 PCM transmission system in the U.S., which will be discussed later.

The results of this multi-faceted approach has been the development by ITT of comprehensive standard families of products in the principal fields of telecommunications, including the following:

1. The Pentaconta family of crossbar switching systems.
2. The Metaconta family of electronic switching systems.

3. Crossbar PABX's.
4. Telephone subscribers' apparatus.
5. Key sets.
6. Submarine cable systems.
7. Microwave radio links.
8. Land coaxial cable systems.
9. PCM transmission systems.
10. Data modems and many others.

ITT's U.S. Telecommunications R.D. & E. Program

In countries where national standards are formal, the cost of R.D. & E. must be borne by the volume of national production. In less formal standard countries, the total volume of ITT production of the standard product is available to offset the R.D. & E. expenses. The U.S., with its national standards set by AT&T, provides for ITT an example of the basic problem of justifying R. & D. cases in the light of the extremely small open market and the almost complete reluctance of the integrated operating companies to buy outside their own manufacturing facilities. Nevertheless, ITT has had a number of successful such products developed in or for the U.S. market including the following:

1. *Ancillary systems for step-by-step central offices.*—Such as Tel-Touch adapters, CAMA, etc.

2. *The A-1 crossbar central office and centrex switching system.*—Although the piece parts and relays employed in this system were those employed by the standard Pentaconta family, the internal system architecture and features were developed specially for the U.S. market.

3. *The TE-400 A, G, and H family of fully solid-state electronic PABX's.*—This was a purely U.S. development based on the TE-400 PABX. As with nearly all innovative efforts in telephony the earliest model, the TE-400 had a history of problems in the field, including with the So. New England Telephone Co. (SNET). Within less than a year those problems were resolved with the resulting excellent product family of TE-400A, G and H. replacing the TE-400. So far as we are aware SNET got no help from AT&T or BTL on the TE-400 problems, nor did ITT.

4. *The TCS 2 Solid State PABX.*—Increasing demand in the U.S. for larger PABX's than the TE-400 A family (50 to 800 lines) has lead ITT to develop the TCS 2 system. This is a direct outgrowth of the TE-400 A products. It uses stored program control with two ITT 1650 miniprocessors in a call sharing mode which provides hight reliability and excellent overload characteristics. The switching network is an end marked matrix of PNPN diodes. By carefully choosing components, techniques and manufacturing procedures, many of which are already used in ITT switching machines, it has been possible to organize the system to be cost effective from below 800 lines to 6,000 lines or slightly more.

5. *PCM Channel Banks—T-124 and T-324.*—PCM goes back a long way in ITT—in fact back to 1937 when Alex Reeves working in ITT's laboratories in France first enunciated the fundamental principles.

Dr. McKay has acknowledged this work of Reeves in the 1937–1938 era as being the foundation upon which the superstructure of present day technology has been erected, but as he also pointed out, the existing technology did not permit commercial application of the principles. BTL quite properly deserves the credit for developing the means to overcome the problem.

Time multiplexing PCM channels make possible a transmission system employing digital techniques to a maximum degree. The advantages of information transmission in digital form are becoming increasingly apparent as the technology of computers produces more and more appropriate semiconductor devices at lower and lower costs.

The first practical application of these principles on a large scale in U.S. was made by the Bell System with the introduction of T-Carrier into their plant in the latter part of 1962. These first systems by Bell used the D1 channel bank, which seems to have been of about 1958 vintage as far as components used are concerned, the system being delayed apparently by repeater development troubles. The design of the channel bank was very reliable and was used by Bell for almost ten years.

In the 1960–1965 period, ITT was considerably involved with European developments in PCM. These developments were following a somewhat different path from the Bell developments, particularly in respect of the channel bank.

The Bell D–1 channel bank was characterized by a particularly complex diode arrangement which had one serious deficiency in that its tracing performance could not be precisely specified. Our European work avoided the critical tracking problems that resulted from Western's temperature stabilized diode by using a non-linear encoder which approximated the diode curve by precisely defined linear segments, which meant that tracking performance could be precisely and uniformly defined. This technique was put into production in 1966 in a 23 channel PCM system for the U.K. Post Office.

By 1967 we had it studied the situation sufficiently to satisfy ourselves that we could manufacture and sell equipment using these principles in the U.S. at lower prices than the Bell equipment even if manufactured in low volume. This equipment would not only be lower in price but would have superior performance by eliminating the tracking adjustments needed on the Bell D–1 and by using less power and being more compact. A team of seven European engineers was brought to the U.S. and together with American engineers began to develop a PCM channel bank to D–1 standards. This equipment, called T 124, was put into manufacture in the second quarter of 1969 and met its objectives of being economical to produce and requiring much less power and space. A primary reason for better performance than the D–1 was the use of more modern and improved semiconductor devices than had been available for use in the older Bell equipment.

Parenthetically, I would like to note that despite certain of the comments in ITT Exhibit 23, the May 21, 1970, analysis of ITT's T 124, the writers pretty clearly understood that the ITT equipment was superior to D–1. In the first place, it was far less expensive, and they conceded that T 124 met six of seven Bell standards. Its alleged failure to meet the so-called tracking tests is a defect in D–1, not T 124. Bell never was able to issue a performance and compatibility specification for D–1, I am sure because it could never solve the problem of specifying precise tracking given the characteristics of its diode arrangement for the D–1 encoder. The writers of the report must have recognized that ITT's non-linear encoder was the preferable solution because BTL had adopted the same solution for its D–2/D–3 development.

In fact, of course, subsequent experience at SNET demonstrated that T–124 will work compatibly with D–1, including for data transmission. The real reason for not going to T–124 is revealed at the end of the report where the writers note that D–3 is expected by September 1972, or in 2½ years. What the writers of the report did not take into account was the possibility, which became a reality, that ITT would as quickly develop a D–3 equivalent which would also be better and cheaper than Western's.

Meanwhile, as I have stated, Bell had been working on a new channel bank called the D–2. This channel bank also used a non-linear encoder similar to the T–124. In addition, the evident principle was to cost reduce the D–1 by time-sharing the encoder and decoder across 96 channels instead of 24 and assembling and disassembling the resultant time multiplexed bit stream into four streams for the unchanged 24 channel line system. This was a complicated idea which no doubt looked good at first. When we heard about it, we decided that solving the problems of going to and from the 96 channel streams would cost more than could be saved by more efficient use of the encoder at the 1970 costs of semiconductors. Thus, ITT proceeded with its development of the T 324, which simply applied the ideas of the T 124 but matched the characteristics of the D–2 and was more cost effective. Apparently, the Bell System decided that D–2 was not the answer because it very soon developed the D–3 channel bank which does essentially the same thing as ITT's T 324. The ITT equipment is adaptable to interworking with either the D–2 or the D–3 and it is also lower priced than either. For the development of the T 324 one of the European engineers who had participated in the T 124 development and had subsequently returned to Europe was brought back to bring with him the latest European ideas, but American engineers formed the balance of the T 324 development team.

Allocation of Funds to U.S. Telecommunications R. & D.

In determining the allocation of funds to U.S. telecommunications R. & D., there is often a temptation to base plans on the large market potential in the AT&T operating companies rather than on the much smaller independent market to which ITT has traditionally enjoyed access. Discouraging such planning has been the experience that developing a superior product has not led to enhanced access to the AT&T market. As indicated in the testimony by Mr. Woodruff, the evaluation period by AT&T has traditionally been long and at the same time Bell Labs and Western Electric are usually pushing ahead with the development of a competitive product which is often ready for sale by the time the evaluation is completed, at which time AT&T decides to buy "in-house."

Thus our observation of AT&T's actions, which contradicts Dr. McKay's testimony, is that AT&T relies almost entirely for innovation on Bell Laboratories and is not really interested in the innovative efforts of outsiders. A few of the operating companies, such as SNET, are willing to look for products outside Bell Labs/Western Electric, but they do this on their own without help or encouragement from

AT&T. As such, the operating companies miss much access to technologies and products developed elsewhere which could assist them in providing more economical telephone service.

Under these conditions, it is only natural that the basic allocation by ITT of funds to U.S. telecommunications R. & D. is proportioned to the current level of sales, and not to the putative AT&T market potential. As shown in ITT Exhibit 21, the 1975 allocation of R. & D. to the N.A. Telecommunications Group (covering the U.S. and Canada) is 3.7% of sales, only slightly higher than the percentage for Europe and growing at the same rate of about 16% over 1974 expenditure, although the total U.S. market exceeds any single European country, or even Europe as a whole.

Release of Bell Technical Information to Independent Manufacturers

One of the most serious problems an outside manufacturer faces is the sheer lack of timely information concerning AT&T's plans for the telephone network. AT&T treats all information as proprietary and doles it out only as it sees fit and often withholds it. There is a procedure under the 1956 Consent Decree and through the USITA manufacturers' sub-committee for obtaining information, but both are inadequate.

Products for the U.S. telephone industry typically take at least 2–3 years to develop. Under these circumstances products from independent manufacturers are almost 2–3 years late when intended for use with new Western products because final interface details are not released by Western until their product is in production. This attitude seems to arise from absolutely literal interpretation of information required to be released (sold) under the 1956 Consent Decree. What is required to be sold is information concerning equipment manufactured by Western, and this is apparently interpreted as not existing until something is manufactured. Furthermore, one purchases what exists at the time of the purchase—subsequent changes are not volunteered but may be purchased if you happen to find out about them.

The USITA manufacturers' subcommittee is the formal channel to obtain compatibility information so that a supplier to the independent telephone companies can make equipment that will interwork with Bell equipment. This channel is also very slow and awkward. For example, at the end of 1971 ITT was beginning the development of a data modem in Europe which was to be somewhat similar to Bell's 208A modem. Our modem was to depend heavily on custom designed large scale integrated (LSI) circuits. When the 208A was announced by Bell in early 1972 we thought that we could include the necessary variations in our LSI circuits to enable them to operate to either U.S. or European standards. We asked for the necessary information to make a modem which would interwork with the Bell device. We knew how to make it. but we needed the Bell parameters.

This question was put on the agenda and discussed at USITA meeting No. 24 on April 10–11, 1973. The answer from Bell was:

> The customer interface for the No. 208A has been defined in a technical information bulletin. Detailed product design information which defines the line interface is being furnished to manufacturers under patent license and technical information agreements to implement non-Bell sources of equivalent units.

ITT certainly did not wish to purchase manufacturing information for the Bell modem. All we needed to know was what parameters we had to match. So we went back to the next meeting on October 3–4, 1973 and asked again. This time Bell changed its mind and without any explanation furnished the information when the minutes were distributed on January 11, 1974. Thus, it took almost two years to obtain the design parameters for this one item of data equipment. By this time ITT's LSI modem was frozen in Europe without provision for the U.S. paramenters and we decided it was not economic to market a U.S. product. This illustrates how the untimely release of information by Bell eliminated competition of others with Western Electric.

The interworking of Bell and non-Bell products is obviously a vital consideration to the independent manufacturer. Another example of the difficulties created for the independent by restrictive or non-release of information is the PCM system described previously. As I stated Bell has never issued a compatibility specification on the D–1. As a result ITT had much trouble trying to find the parameters we should match to make our T 124 PCM channel bank interwork with the Bell D–1 channel bank. We eventually achieved compatibility by purchasing one D–1 bank and making many tests. And for about a year Western refused to sell us a single bank for this purpose, purporting to base their refusal on their policy of selling equipment only to the Bell operating companies. Western was persuaded to sell this item to ITT only after high-level representation by ITT's Legal Staff to Western and AT&T.

If the independent manufacturer is to receive fair treatment we should have the following while retaining all present arrangements:

1. Full and timely advice of plans long before projects enter the manufacturing phase, including regular (four times a year) trend of development briefings for industry.

This information should be volunteered as well as being in response to questions. Present USITA machinery is generally limited to discussion of agenda and specific questions prepared by independent manufacturers. The proposed briefings should be prepared by Bell as an honest reflection of activities. Attendance at these briefings should not be restricted to two people per company but should be open to all.

2. Quarterly publication by BTL of descriptions and status of all current R. and D. work.

3. Release to industry of specifications and objectives used by Western for product development at the time product development is initiated. This is to be updated quarterly as development proceeds and should include operating company requirements.

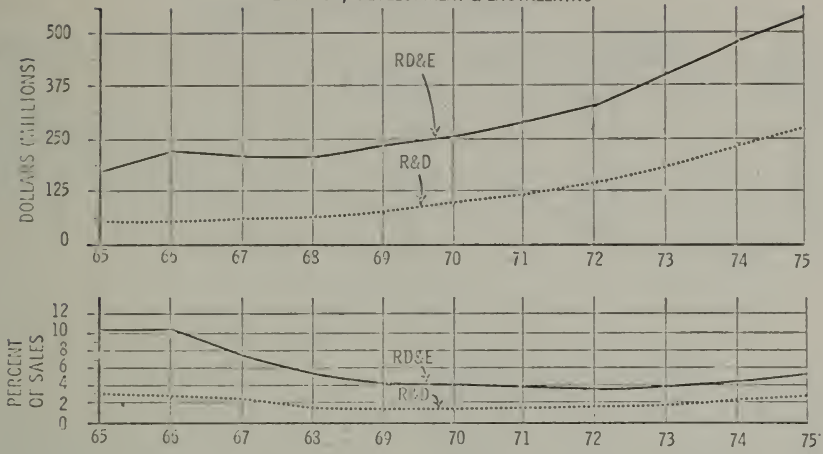
4. Automatic updating of manufacturing information purchased by independent manufacturers.

5. Availability for purchase (or loan) of Western Electric equipment when the independent manufacturer considers this is desirable and appropriate for tests of compatibility and interworking.

As pointed out earlier in my testimony, ITT divisions are quite used to working from less than full manufacturing information in transfers between ITT units and would have no undue difficulty in adopting such a method of interworking with Bell Labs.

ITT Ex. 16

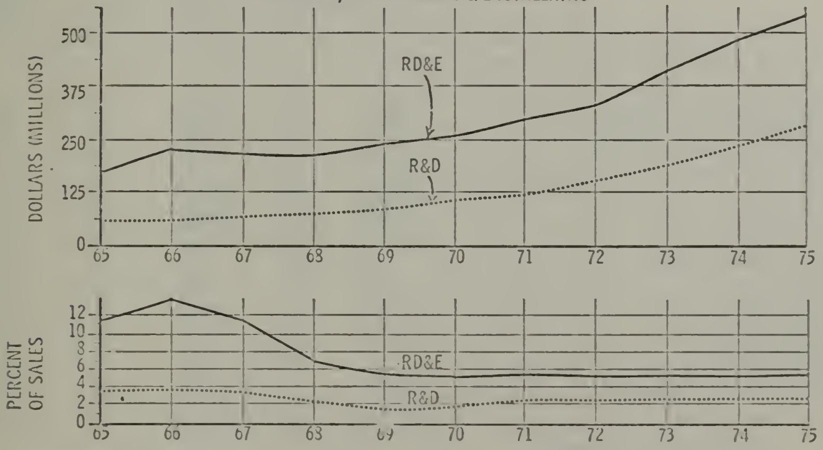
RESEARCH, DEVELOPMENT & ENGINEERING



		1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
SALES	$X MILLIONS	2,121	2,761	4,067	5,475	6,364	7,346	8,557	10,183	11,337	11,611
RD&E	$X MILLIONS	220	210	210	236	257	283	328	400	478	534
	% OF SALES	10.4	7.6	5.2	4.3	4.0	3.9	3.8	3.9	4.2	4.6
R&D	$X MILLIONS	60	62	63	77	96	120	144	188	237	270
	% OF SALES	2.8	2.2	1.5	1.4	1.5	1.6	1.7	1.8	2.1	2.3

ITT Ex. 17

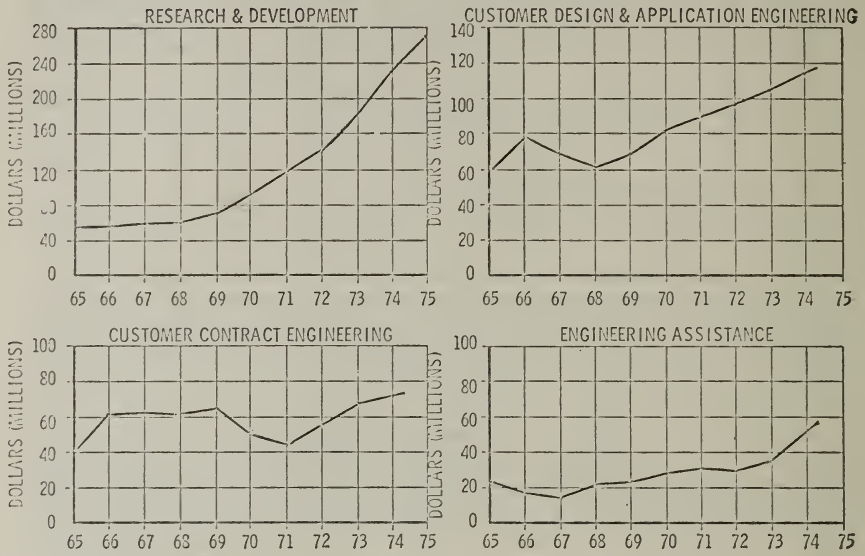
RESEARCH, DEVELOPMENT & ENGINEERING



		1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
MFG.SALES	$X MILLIONS	1,633	1,871	3,050	4,195	4,937	5,368	6,316	7,894	9,542	10,182
RD&E	$X MILLIONS	220	210	210	236	257	283	328	400	478	534
	% OF SALES	13.5	11.2	6.9	5.6	5.2	5.4	5.2	5.1	5.0	5.2
R&D	$X MILLIONS	60	62	63	77	96	120	144	188	237	270
	% OF SALES	3.7	3.3	2.1	1.8	1.9	2.2	2.3	2.4	2.5	2.7

ITT Ex. 18

RESEARCH, DEVELOPMENT & ENGINEERING



ITT SYSTEM

	1974		1975		
	Total (thousand)	Percent of sales	Total (thousands)	Percent of sales	Percent change 1975–74
RESEARCH, DEVELOPMENT, AND ENGINEERING					
Defense/space	$72,815	15.8	$76,620	16.5	5.2
Technical and industrial products	9,339	2.6	10,120	2.6	8.4
Electromechanical components	3,574	3.1	4,358	3.4	21.9
Illumination and electrical products	2,065	1.6	2,214	1.5	7.2
Grinnell	2,722	.6	2,938	.7	7.9
Semiconductors W.W	7,172	3.5	7,684	3.8	7.1
Europe	314,808	5.6	358,944	6.0	14.0
N. A. Telecommunications	14,376	5.9	15,682	6.3	9.1
Latin America	11,946	5.6	15,048	5.9	26.0
Far East and Pacific	6,680	4.9	7,352	4.5	10.1
Telephone operating group	0	0	0	0	0
ICO	0	0	0	0	0
World directories	0	0	0	0	0
Natural resources	9,354	1.4	10,068	1.2	7.6
Food products, services	3,086	.2	2,945	.2	(4.6)
Consumer services	0	0	0	0	0
Financial services	0	0	0	0	0
N. A. Automotive Products	2,185	.7	2,636	.8	20.6
Headquarters and miscellaneous	17,660	0	17,425	0	(1.3)
Total ITT system	477,782	4.2	534,034	4.6	11.8
RESEARCH AND DEVELOPMENT					
Defense/space	8,295	1.8	9,162	2.0	10.5
Technical and industrial products	6,373	1.8	7,140	1.8	12.0
Electromechanical components	2,361	2.1	3,033	2.4	28.5
Illumination and electrical products	1,480	1.2	1,605	1.1	8.4
Grinnell	1,280	.3	1,378	.3	7.7
Semiconductors W.W	6,069	3.0	7,064	3.4	16.4
Europe	169,574	3.0	196,088	3.3	15.6
N.A. Telecommunications	7,914	3.2	9,179	3.7	16.0
Latin America	2,396	1.1	3,152	1.2	31.6
Far East and Pacific	3,420	2.5	3,490	2.2	2.0
Telephone operating group	0	0	0	0	0
ICO	0	0	0	0	0
World directories	0	0	0	0	0
Natural resources	7,175	1.1	7,799	1.0	8.7

ITT SYSTEM

	1974		1975		
	Total (thousand)	Percent of sales	Total (thousands)	Percent of sales	Percent change 1975–74
Food products, services	2, 164	.2	2, 200	.2	1.7
Consumer services	0	0	0	0	0
Financial services	0	0	0	0	0
N. A. Automotive Products	1, 436	.5	1, 568	.5	9.2
Headquarters and miscellaneous	17, 066	0	16, 840	0	(1.3)
Total ITT system	237, 003	2.1	269, 698	2.3	13.8

SLIDE 17

1972 R.D. & E. SALES

	Sales (billions)	R.D. & E. (millons)	Percent R.D. & E. of sales	Engineering personnel
Telecommunications equipment	$1.8	$158	8.8	11, 867
Industrial products	1.6	49	3.1	1, 496
Automotive and consumer	1.0	19	1.9	1, 075
Natural resources	.4	5	1.3	247
Defense and space	.5	95	19.0	3, 718
Food processing and service	1.0	2	.2	71
Subtotal manufacturing	6.3	328	5.3	18, 474
Consumer services	.7			
Telecommunications operations	.2			293
Business and financial services	.4			
Divestible operations	1.0			331
Total	8.6	328	3.8	19, 098

STATEMENT OF TED B. WESTFALL, ITT, TELECOMMUNICATION ADVISER

My name is Ted B. Westfall and I now reside in Delray Beach, Florida.

I am a graduate of the University of Oklahoma with a Bachelor of Science in Business Administration (1940) and of the George Washington University Law School (1949). I am a Certified Public Accountant (Texas) and a member of the bar (District of Columbia.)

I spent four years as a public accountant with Price, Waterhouse & Company in Houston, Texas, and after service in the Navy, joined the General Accounting Office in Washington, D.C. as a senior accountant in the Corporations Audit Division. I was later an Assistant Director of the Corporation Audits Division and at the time of my resignation was Director of all auditing activities of the GAO.

I joined Grace Line, Inc., as an Assistant Vice President in 1952 and was successively Treasurer, Vice President, and finally Executive Vice President and Director.

In October, 1960, I became Vice President of ITT and later was elected a Director. Effective January 1, 1965, I was named Executive Vice President and served both as an Executive Vice President and Director until my resignation from both positions on December 31, 1974.

During my fourteen years with ITT, I have, among other activities, been responsible during substantial periods of time for ITT's:

1. Telephone operations in Puerto Rico and the Virgin Islands and South America;
2. Overseas telephone cable and satellite operations;
3. Domestic and Latin American telecommunications manufacturing activities; and
4. Domestic and overseas international telegraph, telex, leased wire and related record operations.

Since my resignation as Executive Vice President and Director I am employed by ITT as telecommunications advisor.

From the time I joined ITT in 1960, I have studied the structure and practices of the telephone industry in the United States and the problems of an independent manufacturer in developing, manufacturing and selling a quality product in this environment. It is my position that perhaps the greatest opportunity for the Bell System and the Independents to hold down or minimize the continuously increasing costs of telephone service to the consuming public over the medium and long-term future is to open up the Bell equipment market to competition. Whether or not the Bell System's vertical integration violates the antitrust laws, as alleged by the Department of Justice, the Federal Communications Commission still has the responsibility to assure that the Bell System operating companies purchase quality equipment at the lowest price they can obtain and to reflect those savings in their rates to the consumers. This cannot be accomplished so long as the Bell System, through its organizational structure, purchasing policies and procedures and custom and practice assures the purchase by the operating companies of practically all of their telecommunications equipment requirements from Western Electric.

ITT is in a position to supply and has offered to sell apparatus, transmission and switching equipment to the Bell System on a competitive basis and I am sure that others have or will do the same if given a reasonable chance. Moreover, we, and I am sure many others, are willing and anxious to make whatever investments are necessary to supply this market once the opportunity exists. However, to date this opportunity remains largely obscure or non-existent.

AT&T usually responds to these statements by asserting that neither AT&T nor Western determines what the Bell operating telephone companies purchase in the way of equipment, that the operating companies are free to buy where they please and further that their price surveys show that Western's prices in general are far lower than the prices available from general trade manufacturers, (GTM). Those surveys have customarily compared prices to the huge Bell market with those quoted in markets only a fraction of the size of Bell.

The vertical integration of the Bell System with nearly 85% of the telephones in the U.S. means that one manufacturer—Western Electric— has roughly 5½ times the opportunity to achieve scale economies as all of the other U.S. manufacturers taken together. In reality, of course, no single manufacturer can be wholly successful in selling the balance, and instead the remaining 15–20% is divided between the General Telephone (GTE) market and the remainder fought over by five major manufacturers—Automatic Electric (Automatic), North Electric (North), Stromberg-Carlson (S–C), ITT, and Northern Electric (Northern)—and a host of smaller concerns selling particular lines of transmission and apparatus products, such as Vicom, Farinon, Collins, etc. By reason of its affiliation with GTE combined with some sales to non-affiliated independents Automatic now has between 45% and 50% of the independent market, and is therefore at a scale disadvantage of more than 10 to 1. The other manufacturers, including ITT, are even more seriously disadvantaged in relation to Western.

In addition, the single largest manufacturer in the independent market, Automatic, has been faced with the problem of choosing between protecting its profit margins on its captive business and engaging in active price competition. In the post-World War II period the independent market underwent a significant change, no doubt in part due to the vertical structure maintained by Bell. Although Automatic had always been associated with the Theodore Gary group of operating telephone companies, the degree of market foreclosure represented by this vertical integration had been relatively modest. Automatic had traditionally been the largest manufacturer of telephone equipment in the independent industry, but the bulk of its sales had been to non-affiliated companies.

Beginning in 1955 with the acquisition of the Gary group of General Telephone (which subsequently became General Telephone and Electronics, or GTE, following its acquisition of Sylvania) this situation changed. The General System then represented more than 30% of the independent industry in terms of telephones, and thus more than half of Automatic's sales were to affiliated companies. Thereafter, GTE embarked on an extremely aggressive acquisition program of independent telephone companies. GTE used its control of those telephone companies, in the words of the District Court in Hawaii, to channel "all possible purchases of telecommunications equipment for its successively acquired operating companies into its own supplier."* By 1969 the General System represented over 85% of Automatic's sales and the General System procured 79% of its requirements from Automatic. I might add that the primary reason the percentage was as low as that was Automatic's tardiness in developing common control switching. Now that its electronic switching is in production, no doubt Automatic's share of the General System business is higher.

It is not my purpose to reargue the antitrust case which ITT brought against GTE in Hawaii, although the findings of the District Court on the effects of vertical integration on purchasing patterns and practices are certainly instructive. The point I wish to make is that as the General System grew in size and became an increasingly important customer—in fact, nearly the only customer—of Automatic, that company gradually lost its incentive to compete for business outside the General System. Because of regulatory restraints Automatic could not sell to non-affiliates at prices lower than it charged the General System companies.

Automatic chose to maintain margins on its in-house sales at the cost of losing non-affiliated business. One example will suffice. ITT has long distributed its apparatus to the small independents through Graybar, the largest independent distributor of telephone equipment in the U.S. ITT sells to Graybar at a substantial discount from a list price which until recently was at or just below Automatic's apparatus prices. The larger independent holding companies such as the United System, Mid-Continent and Central Telephone have established central warehousing and distributing organizations to which we could sell at distributor prices without disrupting our normal distribution channel to the multitude of small independents.

For many years Central had been a steady customer of Automatic, but ITT's offer of a distributor price was too good to resist. However, Central first approached Automatic to determine if it would match ITT's price. The answer was no, for the explicit reason that meeting ITT's price would mean losing margin on its General System business where ITT's lower prices were immaterial.

A number of state commissions, including New York, California, and North Carolina, have recognized that prices in the independent market are in effect set by Automatic and are not indicative of what prices would be if the whole independent market were open. This Commission can hardly hope to assess Western's performance on the basis of comparisons of prices in such a market. In my judgment, this Commission will never have a basis for determining the reasonableness of Western's prices until a significant portion of Bell System business becomes available to General Trade Manufacturers.

In his testimony, Mr. Woodruff develops the background of ITT's recent quotes for T 324 transmission equipment and Metaconta L switching equipment. I will not repeat his testimony, for I have a different point to make. First, with respect to T 324, as Mr. Woodruff points out, ITT had an existing volume discount schedule in 1973, and those prices are included in Mr. Wolf's 1973 pricing study. At the highest volumes ITT's prices were significantly below Western's prices. Those discount prices were available to all Bell System customers, but in 1973 only Southern New England Telephone Company (SNET) purchased T 324 in any quantity, and its needs were insufficient to obtain the maximum discounts available. As a result, SNET's decision to standardize on T 324 was based on quality and superior features, since ITT's price at the lower volumes was approximately the same as Western's.

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*ITT v. GTE, 351 F. Supp. 1153, 1197 (D. Haw. 1972), appeal pending (9th Cir.)

This was the situation when in late 1973 Pacific Telephone, for the first time that I am personally aware of, opened up its procurement of a major item of equipment to competitive quotations. And the expected happened. With the prospect of a significant annual order, ITT *shaved* its prices, which were already lower than Western's, so that at the upper volume levels, 3000–5000 terminals, ITT quoted nearly 25% below Western's transfer prices.

A similar circumstance arose in connection with the Price Survey Group's recent request for prices on 460,000 lines of electronic switching equipment. ITT decided to treat this request as if the Bell System had put out this volume of business for outside procurement. Based on Dr. McKay's testimony and discussions with representatives of the Bell System Purchased Products Division (BSPPD), we knew that it would be necessary to quote a price lower than Western's transfer prices, since ITT's Metaconta L is functionally equivalent to Bell's ESS.

Obviously ,anyone can quote a price. The problem, of course, is whether ITT could deliver equipment at that price and make a profit. The effort to determine that answer engaged the personal attention of Mr. Geneen, ITT's Chief Executive, as well as ITT's Office of the President and resulted in the expenditure of hundreds of man-hours by engineering and technical and financial personnel in New York and Europe. And the answer was, yes, ITT could do it; and we quoted that lower price to the Price Survey Group.

The point is that it is only the *prospect of real business* that generates real prices. This quotation was no exception, for I am confident that ITT will not spend those thousands of dollars again if this should turn out to be the customary academic exercise for the Price Survey Group. To repeat, only if a substantial portion of Bell System business is truly made available to the competition of manufacturers other than Western will the Commission have a valid benchmark with which to judge the reasonableness of Western's transfer prices to the Bell System operating companies. As against the reality of actual sales, the activities and results of AT&T's Price Survey Group do not provide this Commission with a reliable basis for making that important determination.

Moreover, the testimony and exhibits in this hearing demonstrate that notwithstanding Western's overwhelming volume advantages, combined with all the real and substantial benefits of vertical integration, there is a significant body of products on which the actual prices charged or quoted by ITT and other independent manufacturers are now equal to or lower than Western's. These include PCM carrier equipment, certain Key Systems and Key System apparatus, cross-bar and electronic PABX, accessory equipment for step-by-step switching systems, and selected station equipment. In my judgment, these opportunities would be expanded many fold and the industry's costs would also go down if the Bell System market were open to competitive offerings.

It is a matter of record that our offerings have not led the Bell System to purchase in any substantial quantity from outside manufacturers. (It should be made clear that ITT has quoted competitive prices for different types of equipment at varying volume levels. The dollar volume required to support a competitive price for electronic switching for instance is far greater than that required for carrier equipment such as the T 324.) The Bell System clearly has not sought out the better and/or cheaper products available from GTMs, nor purchased such equipment in those instances where their availability has become manifest. Why is this so? I believe that there are several structural aspects of the Bell System that explain this phenomenon.

First and foremost, of course, is simply the integrated structure of the Bell System. And by that I do not mean to refer simply to the affiliation of a manufacturer with its principal customer. Rather I mean the whole, coordinated one *System* approach described most graphically in the testimony of Dr. Kenneth McKay: with AT&T Engineering providing the operating companies with the highest level engineering advice and assistance and coordinating the efforts of Bell Telephone Laboratories (BTL) and Western to do the same, working with BTL on system engineering and design as well as performance specifications for the products being developed by BTL for Western, informing, advising, recommending to the Operating Companies the specific equipments and applications manufactured by Western, and on the other side deciding which products are to be produced by Western and when.

In operating such a *System* obviously looks inward. The people in that *System* naturally see their personal future dependent on making the *System* work. A problem with an item of Western equipment is viewed as just that: a problem to be solved with the resources of the *System* behind the chief engineer who is experiencing the problem. On the other hand, a problem or inadequacy in an outsider's item of equipment is viewed as a reason for not buying. Only the strongest and most independent engineer will take a chance on an item of equipment without an AT&T recommendation, since (a) he can expect little, if any, help from the *System* if he should encounter a problem and (b) in that unhappy event the problem becomes an adverse reflection on his judgment.

Under these circumstances AT&T management must know that if it does nothing the overwhelming likelihood is that the operating companies will purchase from Western. Thus, the standard response that the Bell operating companies are free to purchase from any source without interference by AT&T is simply a more sophisticated way of achieving the desired result of maximum purchases from the System supplier.

When AT&T's top management fails to take the steps necessary to communicate the availability and recommend the purchase of less expensive or superior GTM equipment or to arrange for volume purchasing when such is essential to obtain lower prices for comparable equipment, that management has not discharged its responsibility. Here I refer specifically to paragraph 5(a) of the license contract which requires AT&T to furnish "advice and assistance" in all matters "pertaining to the efficient, economical and successful conduct" of the business of the operating companies, and paragraph 4, which requires AT&T to "make and maintain continuously adequate arrangements" whereby the operating companies may purchase telephone equipment "at prices which shall be reasonable." Failure to make arrangements to enable or require the operating companies to take advantage of volume discounts available from ITT and other GTMs is a breach of the duty assumed contractually by AT&T for which the operating companies pay 1% of their revenues.

Moreover, AT&T's staff is not above taking affirmative steps to insure that a System company does not stray off the reservation in important procurements. In 1971 New York Telephone came very close to purchasing ITT's T 124 for the twin towers of the World Trade Center in New York City. There were several reasons for this. ITT's equipment had a substantial space advantage over D–1; Western's D–3 was not then scheduled to be commencially available until 1973, and New York Telephone required the equipment in mid-1972; and as originally conceived D–3 was not intended to be end-to-end compatible with D–1, and New York Telephone wanted compatibility.

Notwithstanding, ITT did not receive this order. Instead AT&T Engineering set out to find a "solution" to this problem. The solution was for BTL to develop a plug in accessory to make D–3 compatible with D–1 and for BTL and Western to build the first units, essentially laboratory models, and place them in the WTC without a field trial. This enabled Western to promise in service dates by September 1972, and New York Telephone agreed to that schedule.

Another structural problem is that in the past and now under the new BSPPD, the people in AT&T–BTL responsible for the evaluation of GTM equipment are the same people whose past responsibilities have included decisions as to the design and development of specific items of Western equipment. It is unreasonable to expect expeditious evaluations or recommendations of GTM equipment by the same people and organizations responsible for the design and development of the comparable Western equipment.

ITT's experience in attempting to sell T124 and T324 illustrates both of the above problems. The testimony of Mr. Woodruff and ITT Exhibits 13 and 23 demonstrate that since 1969 there has never been a point in time when ITT's PCM transmission equipment was not cheaper, or better, or both, than the comparable Western equipment. Those facts were known to the Bell System as early as May 1970 with respect to T 124, and by April 1973 in the case of T 324. Yet there does not appear to have been any effort by the AT&T Vice President Transmission to communicate those facts to the Operating Companies and certainly no recommendations to purchase ITT's T 124 or T 324 in preference to Western's D–1 or D–3. In the past year the individual operating companies (SNET and PT&T) were left to their own devices in evaluating ITT's T 324. SNET's experience does not seem to have been communicated to the other companies. It is a fair inference that these omissions may be attributable, at least in part, to the embarrassment ITT's superior performance has caused to those in the AT&T Transmission group responsible for the development of AT&T's line of PCM equipment.

The operations and policies of BTL as a research and development organization also act to the disadvantage of outside manufacturers.

In the first place, the obligations to engage in fundamental research, provide engineering advice (system engineering) and direct "development work by others" are AT&T's in the License Contract. However, the responsibility for fundamental research has been delegated by AT&T to BTL, and responsibility for system engineering is shared between BTL and AT&T, although Western participates to some extent as part of the specific design and development work. Fundamental research and system engineering is paid for primarily by the operating companies through the license contract fees, but the specific design and development work on discrete products referred to as applied engineering and design is performed by BTL and funded by Western.

It is not my purpose to question these arrangements from an operating standpoint, since they may well be an efficient and desirable mode for a vertically integrated organization. The problem is that this division of responsibilities among several corporate entities of that which is AT&T's promised performance under the License Contract obscures their true nature. AT&T treats all the information developed in these three activities as proprietary to be provided to the industry only as AT&T sees fit. As Mr. Ellis describes in his testimony, in the past it has been extremely difficult to find out AT&T's plans for future development of the telephone network. This information is required if outside manufacturers are to be in a position to develop and supply alternatives to Western equipment on a timely basis.

In contrast, Western has complete and total access to this information and, in fact, participates in its creation. No other manufacturer is similarly privileged, *i.e.*, no other manufacturer has instant access to BTL's fundamental research, advance planning, systems engineering, nor the opportunity to fund specific development projects performed by BTL. In short, the "others" referred to in the AT&T License Contract turns out to be only Western. AT&T has decided to use the funds generated by its franchised operating companies and paid for by its general rate payers for the exclusive benefit of its affiliated manufacturer. As I said before, the nature of these payments and their uses are obscured by dividing AT&T's performance of its License Contract obligations among separate legal entities in the System. But if we focus on AT&T alone, it is clear that it owes a duty to the operating companies who pay the bill to look to and utilize the resources of the entire telephone equipment manufacturing industry.

In my judgment there is no logical or business reason why any information which is paid for by the operating companies and made available to Western should be considered proprietary, thus precluding access to other manufacturers. If Western pays for something, then outside manufacturers should be able to obtain the same thing by appropriate payment. What I am saying is that AT&T ought to take seriously its contractual obligation to work with "others"—plural, not singular—rather than looking solely to Western for equipment.

Finally, if there is to be free and open entry into the Bell System, Western should have no part in purchasing its competitors' products for the operating companies. In the first place, Western never has, and could not because of the inherent conflict, act as a true purchasing agent, i.e., seeking out the best equipments at the lowest prices for the benefit of the operating companies. Secondly, whether the operating companies buy direct, or in appropriate cases by centralized procurement, there is no reason why Western margins should be added to GTM prices, nor why Western should have the extraordinary competitive advantages of total intimate access to competitor's product pricing. Further, by acting as purchasing agent, Western has prior knowledge of a potential lost sale at a point in time when by formal or informal methods Western has maximum opportunity to discourage out-of-system purchases.

In summary, it is my testimony that:

1. The Bell System telecommunications equipment market is effectively closed to all but Western Electric equipment and as a result equipment prices to the entire industry are higher than they need be.
2. The Bell System has avoided comparing its Western prices with those which it could realistically obtain from other suppliers for reasonable volumes of Bell procurement.
3. The Bell System has treated as proprietary information that which potential competitors of Western require in order to develop products for sale to the Bell System operating companies on a timely basis.
4. When, despite all of the size, timing, cost and other advantages enjoyed by Western as an integral part of a vertical structure, highly competitive quotes are nonetheless offered by outside suppliers, AT&T has managed to avoid a buy decision.
5. Bell operating companies, although in theory and to some extent in practice free to buy from outsiders, do not do so and in fact are neither responsible for obtaining competitive quotes nor are they generally geared up to do so.
6. AT&T has not solicted competitive quotes from the Bell market and except for the routine price surveys is not organized to do so. As a result, there are no clear policies, practices or procedures for AT&T or its operating companies to test and evaluate competitive equipment. Attempts to sell competitive equipment have been greeted by inaction and long delays.
7. What little purchasing there has been from GTMs is usually through Western and Western is privy to all competitive design, price, quality and other information and is in a position to reduce its prices and take other actions to meet such competition.
8. Western computes profit and return on investment only by product line and is therefore able to "price selectively" to meet competition and to mix results on competitive and monopoly products so that products with no competition can carry underpriced competitive products.
9. The new BSPPD may eventually be of some influence in forcing consideration of non-system products but cannot effectively do so at present because of the basic Bell System structure and apparent lack of a clear sense of direction.

Finally, it should be recognized that my testimony is concerned with only one phase of a rate case, the first phase of which has long since been completed. It is not my purpose to contribute to the "break-up of the Bell System" nor do I contend that AT&T's current rate base should be reduced, even though in some instances the operating companies have paid higher prices that they could have obtained from suppliers other than Western.

On the contrary, I believe that the Bell System rate base is greatly understated by reason of custom and regulatory practices which limit its investors to earnings on historical costs. In fact, we have taken the position in another case now pending before the Commission that historical costs are no longer appropriate in these days of double-digit inflation. Moreover, it is my personal view that past and, to a large extent, current regulatory practices in the gas and electricity fields involving long delays in compensating for increased operating expenses and non-recognition of high replacement costs are endangering the country's economic future.

I note that while this phase of the case is still pending, AT&T has found it necessary to file for very substantially higher earnings. Based on my own knowledge and experience, I can well believe that such increases are fully justified. However, I think continuing cost increases make it all the more important that AT&T be required to open its equipment market to competition and that its operating units be required to consider alternatives to the present virtual 100% support of Western Electric if the System is to be granted the higher rates of return to which it is justly entitled.

If AT&T were to make the structural and policy changes I have suggested earlier, AT&T and therefore the nation would in a very few years receive the benefits of competition and a competitive industry without in any way sacrificing the substantial benefits to the Bell System of Western's existing economies of scale or the real advantages of vertical integration.

For I would concur with Mr. DeButts, who stated in his strong policy statement before NARUC in September 1973 that Western is a great outfit. For that matter, the Bell System is a great System. But the technology of communications has become too complex, as Mr. DeButts also recognized, for one company, Western, and I would add, one System, The Bell System, to have the complete answer to everything. In the immediate past, a small opening of the market in the *Carterfone* decision created an opportunity into which many manufacturers rushed with a large variety of products for the interconnect customer.

Once AT&T begins to look outward and to deal responsibly with all those who have an idea or a product for the telephone network I think it will be both surprised and pleased to find how responsive the competitive world is to its needs. This Commission should do anything and everything it can to encourage and require the Bell System to take advantage of this opportunity.

STATEMENT OF GEORGE M. WOODRUFF III, DIRECTOR, PRODUCT PLANNING TELECOMMUNICATIONS, ITT'S NORTH AMERICAN TELECOMMUNICATION GROUP

My name is George M. Woodruff III, and I reside at Corinth, Mississippi. I am Director, Product Planning Telecommunications for ITT's North American Telecommunications Group. I report to the Vice President and Group General Manager, Mr. Howard Truss.

I received a B.S. degree in Mechanical Engineering with an Industrial Engineering option from Michigan State University in 1956. Prior to entering the Service that year I was briefly a production trainee with A.C. Spark Plug Division of General Motors. After two years in the Service as a Lieutenant in the U.S. Army Ordnance Corps stationed at Aberdeen Proving Ground, Maryland, I entered Purdue University Graduate School receiving a Master of Science degree in August 1959.

My first employment was with Union Carbide Nuclear Company, Oak Ridge, Tennessee, as an electronics buyer, later being promoted to office supervisor. In 1962 I left Union Carbide to work for the Industrial Products Division of Westinghouse Air Brake Company as Assistant to the Director of Marketing, and thereafter, successively, District Sales Manager, Product Manager and Product Market Manager.

In January 1968 I was hired by ITT Telecommunications Apparatus Department in Corinth, Mississippi, and served primarily as Director of Product Planning and Advanced Business Development until September 1972 when I assumed my present position.

North America Telecommunications Group consists of a number of units and divisions in both the United States and Canada. Four of those units manufacture and sell conventional telephony equipment in the United States. The four units are: ITT Telecommunications Apparatus Department, Corinth, Mississippi, which manufactures telephone apparatus including telephones and key systems; ITT Telecommunications Electronic Switching Center, Des Plaines, Illinois, which manufactures electronic PABX's and electronic switching; ITT Telecommunications Electromechanical Switching Center, Milan, Tennessee, which manufactures electromechanical switching, including step-by-step, cross-bar and ancillary systems, such as CAMA (ANI) and Tel-Touch conversion equipment, for step-by-step switching offices, and a small electronic PABX; ITT Telecommunications Transmission Department, Raleigh, North Carolina, which manufactures transmission equipment including PCM Carrier, microwave, multiplex, line treatment and marine radio. Sales of these four units for the period 1970 through 1973 are outlined below.

[In thousands of dollars]

	1970	1971	1972	1973
Corinth	25, 256	29, 301	46, 524	59, 902
Des Plaines	6, 075	6, 064	9, 068	14, 730
Milan	24, 890	40, 293	43, 839	40, 795
Raleigh	16, 440	14, 311	21, 384	28, 423
Total	72, 661	89, 969	120, 815	143, 850

One of my prime functions since joining ITT in 1968 and continuing with my present position has been the development of new products. The primary document employed in ITT's product planning is called a Product Plan. (ITT Exhibit 8 is the form currently in use.) This document analyzes the market and its size, cost targets, price projections and profit, cash flow and other factors which apply to a particular product. The projected capital expenditures, return on investment and assets, profits and project pay back periods are examined and form the basis for the first decision to develop a product. The second key document is the commercial specification which defines the product from the standpoint of cost, performance and other factors to insure that the product when developed will sell at a profit.

Full development can not begin until these two documents have been approved at either Group level, or, if a large program is involved, by the Office of the President ITT. Prior to that only an engineering feasibility study can be made. Such an engineering study may be employed to determine if the project is technically feasible, or if the marketing cost target could possibly be met. With an approved product plan and commercial specification a development case is issued and product development begins.

To define a product or market and its requirements ITT performs market studies employing both inside and outside personnel. Those studies cover statistical analysis, telephony customer interviews as well as interviews of end customers including individual subscribers. Each project must stand on its own merits from a $50,000 investment for a small item, such as key system card, to one involving tens of millions of dollars such as the development of electronic switching systems.

In ITT's market and financial analysis for a product only the independent market, excluding the Bell System and the General System, is normally considered. In the latter markets the only projected sales which would be accepted as realistic possibilities would be to the interconnect market. This is not to say that we do not make every reasonable effort to design products to be acceptable to those systems, nor that we slight them in our sales efforts. Long experience, however, has taught us that realistic investment, cost, price decisions cannot be based on projected sales to those systems.

ITT has generally followed Western very closely in the apparatus area, and in several instances purchased Western drawings. However, many products such as the 6 button wall key telephone and 18, 24, 30 button key telephone have not been manufactured by Corinth because the anticipated returns on investment were inadequate. Corinth did design a 30 button telephone following Western's 10/20 format, as tooling expense was minimal. In PCM transmission ITT has attempted to be end to end compatible with Western Electric, but our basic design approaches have necessarily differed both for technical quality reasons and because of the constraints of our volumes and cost requirements. In switching and PABX's we have generally followed our own paths to avail the limited U.S. market of the resources of ITT worldwide.

During the development process marketing is constantly monitoring costs, performance and schedules, as development projects will be halted at any point the project apparently can not meet cost and/or commercial requirements. New products evolve from several demands. New competitive products, new customer needs, changes in customer needs and changes in technology. Pricing also is a mixture of many factors: what the end subscriber will pay in tariffs, what the operating telephone company can afford, what related products sell for or what savings can be achieved. Cost targets are set based on price and determine the economic viability of the product.

For several years I have had personal contact and discussions with Mr. Wolf and other members of the AT&T Price Survey Group. I have been responsible for supplying him with the current prices on some ITT products which are included in the studies of that Group. In particular, I personally validated the ITT Apparatus prices used in both the 1972 and 1973 studies which have been submitted as part of the record in this case.

Following my review of the 1972 study ITT, through its counsel Mr. McKee, informed the FCC Trial Staff in substance that the prices used by Mr. Wolf were accurate but not necessarily the prices which ITT would actually sell equipment to the Bell System if firm volume orders were placed on it. (ITT Exhibit 9 is a copy of that exchange of correspondence.)

The truth of that statement can be demonstrated by reference to ITT Exhibit 10, a letter dated February 25, 1974 from Mr. Howard Truss, Vice President and General Manager Northern American Telecommunications, to Walter Kelly, the AT&T Vice President designated to conduct the study of the Bell System's policies and practices for procuring equipment from general trade manufacturers (GTM) and whose study ultimately led to the creation of the Bell System Purchased Products Division (BSPPD). As the letter indicates, it was written subsequent to a meeting the object of which was to inform Mr. Kelly, and through him the Bell System, that there were products that could be purchased immediately from ITT that would offer substantial advantages over comparable Western products in feature or price, or both. It was our expressed request and hope that decisions to purchase would not have to await the completion of this long overdue study. Unfortunately that hope has not been realized.

With respect to the CAMA equipment mentioned in the letter ITT's then current prices were based on no volume commitment of any kind by AT&T, Western, or any of the Bell Operating Companies. Following that letter we did enter into negotiations with Western, which for labor reasons had to install this equipment and which acted as purchasing agent for the operating companies. During those negotiations ITT offered to reduce its prices by 15% for an assured volume of approximately $10 million in orders per year. Those negotiations ultimately foundered on Western's claimed inability to commit, or to make any arrangements for committing, the Bell operating companies to a minimum quantity of business. Thus, to repeat, the prices of ITT's

CAMA equipment then being sold to the Bell System, which would be the prices used in a Price Survey Group study to compare Western's ANI–D equipment, are not the prices at which we would be willing to sell to the Bell System if Western would commit, or if arrangements could be made for the operating companies to commit, to a minimum volume of business. I should add that ITT was not simply trying to buy business with a lower price; rather with an assured volume known in advance there were opportunities for economies which make the lower price equally profitable to ITT.

The same is true of the apparatus equipment mentioned in Mr. Truss' letter. Those numbers refer to the following kinds of station equipment:

500 CL (BA) 30M—standard desk rotary dial telephone in colors
554 CL (BA) 30M—standard wall mounted telephone in colors
2500 CL (BA) 30M—standard push button desk telephone in colors
2554 CL (BA) 30M—standard push button wall telephone in colors
2200 CL (BA) 30M—Push button desk dial-in-handset telephone in colors
2254 CL (BA) 30M—Push button wall dial-in-handset telephone in colors

Those particular items were chosen because at current costs we felt that we could offer to the Bell System a significantly lower price than the current transfer prices of Western to the Bell operating companies. However, in this instance it was even more important to have a commitment from Bell to purchase a minimum number of units because it would be necessary for ITT, from a practical marketing standpoint, to offer the same low prices to its existing customers. If the Bell System were to buy only a few thousand units at the lower prices, we would have simply sacrificed margin on our existing business for no purpose. However, we felt that at approximately one million units (which I estimate to be about 15% of Bell's apparatus requirements) ITT's total profits on its existing and newly acquired Bell business would be greater than the profits on a smaller volume of business being done with the independents at a higher price. It happens that these items of equipment are virtually identical to the Western product and, in fact, in most instances the piece parts are interchangeable. Nevertheless, there has been no follow-up by AT&T or Western on the offer contained in Mr. Truss' letter. Accordingly, there have been no prices quoted to the Bell System different from those set forth in the study by the Price Survey Group, but again those prices are not necessarily the prices at which ITT would sell to the Bell System at agreed upon volume.

In a variety of traffic and feature configurations ITT's prices on its electronic PABX series are already lower than Western's existing prices for its equipment, a fact which has been conceded in this hearing at least as to the TE 400 A, G and H series. With respect to TCS 2, pricing is somewhat more complicated because this is a large processor controlled PBX with capacity from 600 to 6600 lines. The TCS 2 is not precisely comparable to Western's ESS 101, but it covers a portion of the spectrum of applications and functions of that equipment. In the latter part of 1974 ITT quoted TCS 2 against an ESS 101 application at South Western Bell at a price of $800,000 as against an ESS 101 cost of $1 million. We did not receive that order, however, because, we were told, the operating company had already invested $500,000 in that equipment for a different user who had subsequently decided not to accept the equipment and the out of pocket cost for the new application was only an additional $500,000. In this salvage situation the ESS 101 enjoyed an incremental cost advantage of $300,000, but this transaction serves to confirm the statement in the Truss letter, which was and remains true, that in most applications the TCS 2 offers price and feature advantages over ESS 101. In addition the TCS 2 is very attractive against the Western 812A in certain sizes, traffic and feature configurations.

The final item of equipment of those identified in the letter is ITT's T 324 PCM channel banks and repeaters equivalent to Western's D–3 series. This quotation and ITT's efforts to sell this equipment to the Bell System is a long story, but I hope it will have a happy ending. First, by way of background, ITT introduced T 324 in early 1973 approximately contemporaneously with Western's introduction of D–3. Both products were successors to the D–1/T 124 PCM equipment and embodied the latest solid state technology. In late 1972 and early 1973 Raleigh commenced an extensive series of product seminars for various Bell operating companies, and those seminars continued well into 1974. ITT Exhibit 11 is a schedule showing the dates seminars were conducted and the reaction as we judged it. To put some of the optimistic comments in perspective I have had prepared ITT Exhibit 12 which is a compilation of actual orders of PCM equipment from the Bell operating companies in 1973 and 1974.

In April 1973 a three day session was held with Southern New England Telephone (SNET) the result of which was to induce that company, alone among all the Bell operating companies, to standardize on ITT's T 324. Previously, for several years SNET had been dividing D–1/T 124 business between Western and ITT on a 50–50 basis. ITT's price to SNET was about equal to Western Electric's, but T 324 offered significant savings in space and power—as had T 124—over the Western equivalent.

In April 1973 ITT published its first volume adjustments, a copy of which was furnished to the Price Survey Group and is included in the 1973 study (AT&T Ex. 36).

Pacific Telephone and Telegraph (PT&T) examined one ITT terminal which was provided on a no charge basis in July 1973. In late 1973 PT&T solicited quotations on D–3 equivalent equipment from Western, ITT and General Electric. In December 1973 ITT submitted its price quotation. A copy of that quotation has been introduced in evidence as ITT Exhibit 2 and was an enclosure to ITT Exhibit 10. That quotation represented a further downward adjustment of ITT prices from the price schedule published in April 1973. At the 3,000 to 5,000 terminal level ITT's price was approximately 25% below Western's price at that time.

Certain differences were noted between T 324 and issue number 2 of the D–3 compatibility specifications which ITT did not have at that time. PT&T subsequently purchased eight more terminals with the modifications for extensive field trial. Two terminals were also provided at no charge for training. This evaluation proceses was not completed until the 4th quarter of 1974 and, of course, it was successful. For some reason PT&T either chose not to rely on, or was unaware of, the BTL evaluation in March 1974 which found ITT's T 324 technically suitable for use by the Bell System. Nor did it choose to rely on SNET's successful experience with T 324, and so far as we are aware, neither AT&T Engineering nor BTL assisted or participated in the PT&T evaluation process.

In January or February 1974 we were advised that Western had reduced its price on D–3 equipment by 9%, although prices on most other items of equipment were increased. There were further price adjustments in mid-1974, but the price of D–3 was increased only 2% while prices on other items of equipment were increased from 6–15%. ITT's prices also changed, but the basic relationship to Western's price remained unchanged—at the highest volume level ITT remained approximately 15% below Western.

AT&T took no action with ITT with respect to Mr. Truss's February letter, but after the formation of the BSPPD the subject of buying PCM equipment from ITT was very quickly raised with that Group. In September and early October Mr. Ken Ray, Director of Marketing of the Raleigh plant, and I met with Mr. Wolf and Mr. Richard Hermann to resolve certain misunderstandings concerning ITT's then current prices. The result of those sessions was concurrence on their part that ITT's price was in fact approximately 15% lower than Western's at the 5,000 terminal level. However, they said that they, meaning the BSPPD, had no power to purchase equipment from ITT with guaranteed volumes.

Notwithstanding, Mr. Ray and I were told that if ITT were willing to quote that low price without any assurance of volume, BSPPD was confident that orders would develop from the Bell System companies sufficient to justify ITT's having quoted that price. It should be obvious that such a quotation would represent a rather large exercise in faith on the part of ITT, since it would require ITT to reduce its existing prices to SNET on business which had been captured from Western on the basis of quality rather than price without any assurance of obtaining additional business to make the sacrifice worthwhile. I estimated that depending on SNET's 1975 orders ITT faced a potential loss of approximately $600,000 if new business did not materialize.

Nevertheless, ITT decided to accept the challenge and on October 23, 1974, submitted its lowest price quotations withdrawing all volume restrictions. A copy of the cover letter is annexed to my testimony as ITT Exhibit 13.

The submission of this quotation did lead to a series of long and, I must say, arduous negotiations concerning the general terms and conditions, technical specifications, quality control measures, etc., against which the Bell operating companies can place such orders. Those negotiations were not yet concluded at the time my testimony was prepared in January 1975. It should be noted that for nearly two years SNET has been purchasing this equipment on a purchase order basis without any problem. In any event, ITT has as yet enjoyed no increase in order input from the Bell operating companies that would be attributable to the price quotation first made to PT&T in December 1973. As I said at the outset, I hope this story will have a happy ending, but it will have been an extremely long and difficult struggle to persuade the Bell System to accept the benefit of substantially lower prices for superior equipment. In the meantime, of course, Western has suffered no diminution of its order input at its higher prices.

The most recent example relates to electronic switching. Mr. Wolf's 1973 Price Study contains a comparison which I was informed happens to be with ITT's electronic Metaconta L office in Las Vegas, and indicates that Western's ESS price would have been about 70% of ITT's price. In August 1974 we learned that the AT&T Price Survey Group was going to conduct a comprehensive switching study. Prior to the formal issuance AT&T personnel visited ITT Des Plaines to review the specifications. The proposal was received by ITT on September 25, 1974, copy attached as ITT Exhibit 14. Upon receipt ITT began the engineering effort required to prepare a quotation.

On October 30, 1974 I met with Mr. Geneen and other members of the Office of the President and New York Staff. This meeting resulted in a total corporate interest that a competitive proposal be issued so long as such a proposal was profitable. In subsequent meetings with individuals, including Mr. R. E. Bennett, Executive Vice President, Mr. Frank Barnes, Senior Vice President and Group Product Manager, and Mr. Al Cookson, Senior Vice President Engineering, it was decided to form a task force 1) to determine hard cost estimates at the indicated volume levels and 2) to prepare complete financial analyses, including cash flow under the assumption that a contract would actually be issued.

The basic team was seven New York Staff members and myself coupled with ITT Des Plaines personnel and additional assistance from ITT Europe switching manufacturing areas. In order to complete what became a very large exercise I was twice forced to ask for extensions of the bid date from Mr. Wolf. In both cases the extensions were granted. ITT submitted the propasal to AT&T on January 14, 1975, a copy of which is attached as ITT Exhibit 15.

While the total package was quite extensive the most difficult problem was the determination of a competitive price level. Switching pricing is at best difficult to compare because even offices of the same size differ in traffic and features. From time to time ITT has been able to obtain inputs as to current Western pricing on D-3 PCM carrier and station apparatus. On switching pricing, however, we had until recently no information.

In July 1974 we received through ITT Legal the prices of three relatively new offices from AT&T. In November we were successful in obtaining specifications for those offices. Those offices were then engineered and costed and compared with the WE price. As mentioned above, I was also advised that the electronic office comparison in the 1973 price study submitted in this proceeding was against our Los Vegas South Five office. These limited and insufficient inputs were the basis for formulation of a price strategy to achieve a bid price approximately 10% below what we calculate to be current Western pricing on ESS #1. This price level was compared with our projected costs, and the end result was a decision to submit the proposal.

I stated we believe our price should be competitive, but I am unable to forecast a reliability for that. I must add, based on past independent bid results, other manufacturers may also offer attractive proposals. AT&T, however, will hold that information in confidence and really our only interest is our proposal versus Western. The importance of this story however is that it indicates ITT's, and we assume others, willingness to go to a great deal of effort and expense in an attempt to offer AT&T an attractive proposal for possible sales to the Bell

System, even when the request indicates the possibility that it is only an academic exercise for the Price Survey Group.

The severe problems (of which the above are a representative sample) facing an outside manufacturer in its effort to sell to the Bell System begin with the extreme reluctance of the System to go outside for equipment and end with the ardent desire of the System to turn inward as soon as possible.

It is a simple fact of life, which every general trade manufacturer (GTM) has had to come to terms with, that AT&T and the Bell operating companies are reluctant to purchase from GTMs. This reluctance is based on many factors including System loyalty ("If you were building a brick house and your wife made bricks, who would you buy bricks from?"), and understandable psychological desire not to take any unnecessary personal risks (if it's made by Western and it doesn't work, it's Western's problem; if it's made by ITT and it doesn't work, it's the person who recommended buying outside whose career prospects in the Bell System diminish), but most importantly a System structure that renders the individual operating companies ill-equipped to evaluate or procure equipment from manufacturers outside the System. System engineering and compatibility problems are performed or solved at the AT&T–BTL level, such services being paid for by the license contract fees. As a result our salesmen often receive the response, "We take our cue from 195", meaning 195 Broadway in New York City, AT&T's corporate headquarters.

This means that in almost every case to have any prospect of success a major sales effort must be made at AT&T, which until recently was itself very reluctant to devote much in the way of resources to evaluation of GTM products. At the AT&T level we would be met by the standard line, "We don't control the operating companies' decisions as to equipment, go sell your products to them". It usually required pressure from the operating companies to induce AT&T to evaluate a product, and even then about the best one could expect is a rating "acceptable" or "suitable" for use in the Bell System. I am aware of only one instance in which AT&T affirmatively recommended an ITT product (Tel-Touch) over the comparable Western product, and in every case the process has been protracted, requiring considerable effort and followup. There is just no question in my mind that AT&T has had no real interest in the innovative efforts of others. Instead, we have been something of a nuisance, barely tolerated, subjected to delays of all kinds and certainly not looked to as a viable alternative to procurement from Western.

The second major problem is that in those few instances where a GTM is succesful in developing a product, which does meet a real need in the Bell System, and which the operating companies begin to purchase in any substantial quantity, the Bell System does not follow the kinds of purchasing practices it espouses and adopts in conducting its own business. What I would call the sound purchasing practices of an organization subject to the ordinary competitive pressures and interested in obtaining quality products at the lowest possible price are described very succinctly in the testimony of Mr. Gluck (pp. 23–24) as follows:

> Western Electric's approach to attaining low prices from its suppliers include (a) the application of sound standard purchasing practices by its buyers—e.g., using national contracts, developing alternative suppliers, tailoring purchasing

> arrangements to allow supplier to achieve economies which can be passed on, and changing distribution practices to lower warehousing, handling or other expenses; and (b) aggressively seeking additional economies through a formal vendor support program which results in recommendations as to how a purchased product can be redesigned to make it less costly or how a supplier can adopt more efficient tooling and manufacturing setups.

Those are not the practices which Western or the Bell operating companies follow when procuring equipment from outside manufacturers. I have already described how both Western and the new BSPPD have told us that they could not take advantage of volume discounts because of an inability to commit the operating companies to a minimum level of purchases. But it goes beyond that.

Purchases from outside vendors are episodic; no loyalty is shown to a vendor who has met a need. Instead BTL and Western immediately institute a program to develop a comparable piece of equipment, and as soon as the operating companies are informed by AT&T Engineering of its potential availability they begin cutting back purchases from the outside manufacturer in anticipation of buying from Western. Two examples come to mind. First Nippon Electric achieved considerable success in meeting the needs of the Bell operating companies for a crossbar PABX at a time when Western had only its step-by-step PBX to offer. Western and BTL apparently developed the 770A on a crash basis and marketed it to the System at a price which I, as a marketing man, knew at the time could only be designed to meet the Nippon Electric price and in no way could return to Western its usual or customary profit margins. I understand that fact has since been confirmed by testimony in this proceeding. Moreover, the 770A was apparently not completely field-trialed and ready for manufacture, as I understand that more than 100 class A changes were required after Western began delivering 770A PBXs to the operating companies. A class A change is one which requires retrofitting of all existing units in service. Notwithstanding, Nippon's sales were severely impacted by the 770A.

ITT has suffered a similar experience with its CAMA identifier, a piece of step-by-step accessory equipment comparable to Western's ANI. ITT's CAMA was demonstrably superior to ANI C. It received BTL and AT&T approval, and many operating companies had commenced their conversion programs using ITT's equipment. This was a small total market, probably not exceeding $60 million in sales to the Bell System for their entire conversion efforts, but nevertheless Western and BTL developed a competing product, ANI–D. The impact of the announcement of its pending availability was dramatic.

In 1973 ITT's CAMA order input was $1,690,000 and growing; in 1974 after the announcement of the availability of ANI–D many orders were cancelled and total order input dropped to $504,000. We were told that the ANI–D embodied some improvements for a slightly lower price. As to the former, in any normal vendor-buyer relationship, suggestions for product improvements would have been communicated to us, and ITT would have been happy to make them. As to the price factor, since we must sell through Western which adds a markup that is unknown to us, it is difficult to evaluate our price competitiveness, but I have already stated that we offered a 15% price reduction for guaranteed volume.

The point of these examples is that when Western is first to develop and market a product, the GTM who develops a comparable product is met with the argument that the operating companies have "standardized" on Western and are not interested in the competing product unless it offers unusual feature or price advantages. On the other hand, when the GTM has either met a need for successfully sold a product based on the significant price or feature advantages the arguments in favor of standardization appear to become irrelevant. Western invariably develops a comparable product, the operating companies immediately switch back to Western, and the GTM is left high and dry. As a marketing man and a purchasing man I can say, that is not the way to get quality equipment at the most reasonable prices.

SOCIAL IMPLICATIONS OF COMPUTER/TELECOMMUNICATIONS SYSTEMS [1]

By Edwin B. Parker, Professor of Communication, with the assistance of Marc Porat, Research Assistant

INTRODUCTION

In the following remarks I have rejected the two most common approaches to a discussion of the social implications of computer/telecommunications systems as being too narrowly focussed on the technology. I prefer a broader approach that looks at the social problems our societies face and the institutional changes that might be appropriate for solving them, with computer/telecommunications technology in a subordinate role as one of the tools available for social problem solving.

The first of the rejected approaches is technological forecasting. Technological forecasting ues a variety of techniques, including the Delphi technique pioneered at the Rand Corporation, to project the trends in the technology. Such projections usually have an implicit assumption that there will be no significant change in the institutional structures controlling the technology. Forecasters can then speculate on the social consequences of the technological trends using social consensus to validate their speculations. Such speculation often looks optimistically at the potential of the technology, because the experts engaged in the forecasting exercise have a vested interest in the continued development of the technology they have expertise in. Such an approach carries with it the risk of falsely assuming technological determinism and thus implicitly or explicitly arguing that no social policy actions should be taken (other than to promote the development of the technology itself) because the social results are inevitable.

This assumption of technological determinism, although often used to defend conservative institutions, is consistent with the Marxist argument that in the grand sweep of History (with a capital H), the underlying technology (the means of production) largely determines the institutional structure (the social organization of production) and that these institutions in turn shape the ideology of a society (the superstructure), that is its laws, political theories, science, art, etc. But in the shorter time scales we are concerned with when asking questions of social policy, what goes in the realm of ideas (for example, in scientific research) may influence the underlying means of production. And to a perhaps greater extent, the social institutions determine which areas of science receive funding for continued investigation and which technological possibilities are in fact implemented. Whatever we conclude about Historical Determinism, as viewed over a period of centuries. policy makers must deal with many delevant questions of national and international policy in the scale of years and decades. Policy makers may be merely trying to maintain their power by keeping in step with historical inevitability or they may be actually influencing the course of history. In either case, the focus should not be on the technology itself, but on the social policy options and the probable consequences of those policy choices.

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[1] [Paper presented at Session A of the Conference on Computer/Telecommunications Policies held in Paris, France on February 4–5, 1975 under the sponsorship of the Committee for Scientific and Technological Policy of the Organization for Economic Cooperation and Development (OECD)].

The second rejected approach is that of technology assessment, in which one measures (or speculates about) the beneficial or harmful results of alternate forms of the technology. This is a valid approach for many purposes. But, as I have argued elsewhere (Parker, 1973), the short to medium range social effects are determined not by the technology itself, but by the social institutions that can stimulate, inhibit, apply or divert the technology. The same technology that could enrich some people and institutions at the expense of others could also be used to increase the wealth of all while narrowing the gap between rich and poor. The same technology that could lead to centralized systems of social control such as those caricatured in George Orwell's 1984, could also be used to foster a participatory democracy in which political power is more widely distributed throughout the society. Which outcomes are achieved will depend on the institutional structure controlling the development of the technology. Therefore we should focus our attention on social problems and institutional analysis in order to keep the technology in appropriate perspective.

In the third approach to social implications of information technology that I recommend, awareness of the potential of the technology is still important. But policy analysis should instead begin with the social problems and social goals that need urgent attention, and purposively structure both the technology and institutions controlling the technology in order to accomplish long-range policy objectivenes. The technology sets limits or constraints on what is possible, but the more interesting questions concern the alternatives within those limits that are selected or rejected by the relevant institutions. In many cases, the key to solution of social problems is not changes in technology per se, but in changes in institutional structure. We all know that established institutions, whether governmental or business, are often extremely resistant to change. There are perhaps three occasions or kinds of events that are sufficiently destabilizing to institutions that there is a real opportunity for change. One is during a time of political crisis. The second is during a time of economic crisis. The third is during a time of technological change. In the third instance, institutions are forced to adapt to, or defend themselves against, forces of change inherent in new technology. The key policy questions at such times should concern how to deal with the opportunity to restructure institutions so that they can better serve present and future social needs.

This focus on how institutions might be changed to better utilize relevant technologies has a disadvantage that should be made clear at the outset. By pointing out favorable scenarios of what is possible with the technology, given changes in institutions, there is a tendency to be unrealisticly optimistic. Technology can be misused and institutions controlling technologies for their own ends may often exacerbate social problems rather than solve them. A conditional statement of favorable possible outcomes, depending on appropriate policy action, may be misinterpreted as a prediction of favorable consequences that follow from the technology itself rather than correctly interpreted as a statement of possible futures, with perhaps low probability of implementation by appropirate institutions. Being by nature an optimist, I have chosen to focus on the positive potential of the technological opportunities, even through a realistic prediction would anticipate most of the opportunities being missed and less socially desirable consequences resulting.

The social policy questions that I choose to focus on in this paper are economic ones. Although I am not an economist by training, I have convinced myself that a significant source of the present world-wide economic problems lies outside the boundaries of conventional economic theory in an area I do know something about. The relative lack of success of economic policies in dealing with the current worldwide economic problems may make this an opportune time for an analysis by an outsider to be heard by policy makers.

A BOLD HYPOTHESIS

Let me present a bold, only partially tested, hypothesis about the current state of the world economy. The economic crisis of the mid 1970s is a symptom of a major social transition, not transitory economic dislocations. The underlying cause, I hypothesize, is the shift of the major industrial societies to post-industrial societies and the concurrent introduction of post-industrial elements into the industrialization process in the lesser developed countries. In OECD countries our economies, our economic theories and our social institutions are largely geared to agricultural and industrial production and consumption. Now we are undergoing a major historical upheaval. Instead of being able to plan economic growth on the assumption of unlimited supply of energy and materials, we are now confronted with real limits to physical growth. No longer can we have unlimited or unrestrained growth of population, of material consumption or of environmental pollution. These new kinds of problems are now challenging the economic theories and institutions that were devised to stimulate and to cope with the growth of the industrial wealth.

We can now see more clearly than we could a few years ago how to characterize the post-industrial society. We are in the midst of a sometimes painful transition from an industrial society to an information society. We are moving into an era in which the dominant labor activity is information processing rather than industrial production. The growth of computer, communications and other information technology in the past 25 years has been aptly dubbed "a second industrial revolution."

In the industrial age, man was able to use his information processing power to design machines that greatly augmented his physical capacity. Those machines could use large amounts of energy to shape and transport physicial goods under man's control and direction. In other words, man provided the necessary information to build and to control the machines that substituted for and vastly augmented human physical energy. In the information age that we are entering, the characteristic machine is one that processes information, augmenting not human physical energy but instead augmenting human information processing. The difference is a significant one. Since energy is used to manipulate symbols rather than physical objects, the consumption of energy and materials can be made arbitrarily small by using smaller and smaller physical representations of symbols in our information machines. This means that in an information age unlimited economic growth is theoretically possible even though we reach a steady zero-growth state with respect to energy and materials.

There are two aspects to this potentially unlimited growth. One is that some present consumption and much new consumption could be diverted into information-intensive rather than energy-intensive goods and services. The other is that continued application of information (for example, research and development) could lead to more efficient use of available energy and materials, permitting real growth of output given stable inputs. Buckminster Fuller, in his book "Operating Manual for Spaceship Earth," (Fuller, 1969) perhaps has the latter point in mind when arguing that the potential for economic growth is unlimited because economic growth is dependent on limited physical resources coupled with unlimited metaphysical resources.

The kinds of economic policies and economic theories appropriate to the industrial age are not the most appropriate theories or effective policies for an information age. Information is not a commodity like other industrial commodities. I will attempt to show that policies that were appropriate when information activities were a small part of the total economy become inappropriate and even counter-productive when information activities constitute the largest sector of national economies. This is because information is difficult to convert into an appropriable commodity whose title can be easily transferred from one economic agent to another. Even if we already had the better theories and policies needed for an information age, we are in the meantime faced with the even more difficult problem of successfully steering our societies and our economies through the difficult transition period. I'll return to these policy issues after presenting some descriptive data consistent with my hypothesis about the basic structural change underlying current economic difficulties.

THE INFORMATION SOCIETY

A society can reasonably be characterized by what most of its people do and an economy can be characterized by the major economic activities contributing to the National Income. For example, the United States of 1860 was still predominantly an agricultural society because more workers within the U.S. labor force were engaged in agriculture than were engaged in either industrial or service occupations. Agriculture contributed a significant portion of the national income. By the middle of the 20th century, the United States was predominantly an industrial society, properly so-called because a higher percentage of the labor force was engaged in manufacturing than in other occupations. Now, since about 1950, the structure of the U.S. economy has been changing.

By the conventional classification scheme of primary (agriculture and extractive activities), secondary (manufacturing), and tertiary (service activities), the relative decline of both primary and secondary activities is reflected in the relative increase in tertiary or service activities. That traditional classification scheme now conceals more than it exposes. A century ago service occupations included a large number of personal servants, shoe-shine boys, and others providing physical services. Now, maids, butlers and shoe-shine boys are rare, and most service occupations are less often physical services and are now primarily information services (lawyers, accountants and computer programmers, for example). Even within the primary and secondary sectors of the economy, many of the occupations are concerned with information processing rather than processing of energy and materials. In U.S. agri-business, a growing proportion of the total labor force is in managerial, clerical, or financial occupations. In manufacturing, the number of blue-collar workers on the production line is declining relative to the white-collar information processing jobs.

My colleague Marc Porat (1974) has analyzed data on the United States labor force made available by the U.S. Bureau of Labor Statistics. We chose to look at U.S. data partly on the basis of convenience, but also because the U.S. is farther advanced into the post-industrial information age, and therefore, U.S. experience may be viewed as an indicator of things to come in other industrialized societies.

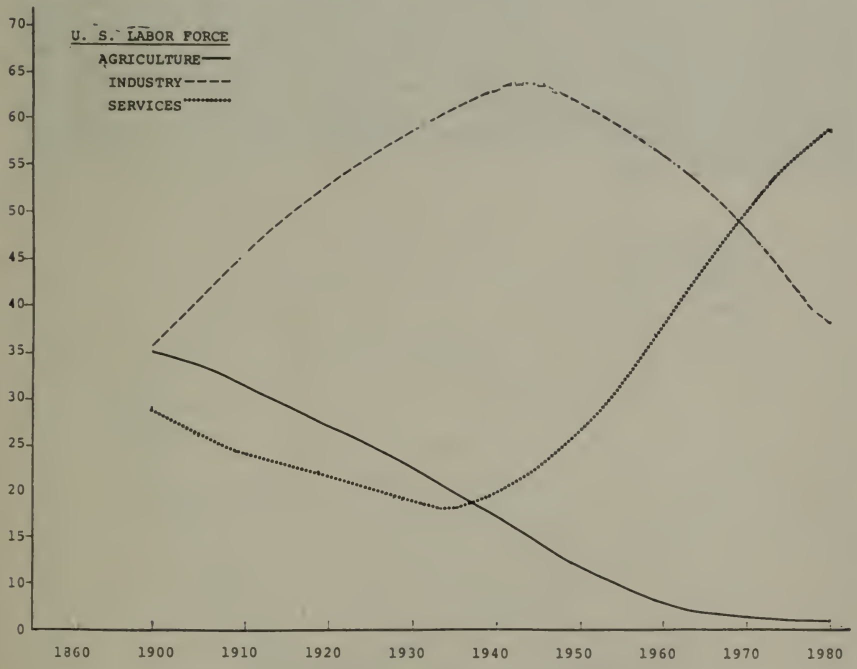

Figure 1. U.S. Labor Force: 3 Sector Aggregation.

Figure 1 shows the percentages of the U.S. labor engaged in agricultural, industrial, and service occupations from 1860 to 1980, based on Bureau of Labor Statistics data through 1970 and BLS occupational projections for 1980. By this rather conventional classification scheme, agriculture has continued to decline relative to other sectors of the economy, despite real gains in agricultural output. Industrial activities reached their relative peak about 1950 and have been declining since. Service occupations are growing rapidly and employing an ever greater percentage of the labor force.

Figure 2 is based on a slightly different classification scheme in which all occupations where the primary activity is processing information have been separately classified into a fourth or "information sector" of the economy. The other three categories are net of information processing occupations. (Appendix A lists the occupations that have been classified into each of these four categories. In the case of information occupations, a further classification is provided to indicate how they were distributed into the three original categories.)

The resulting four-fold classification shows that service occupations (net of information services) are now a smaller percentage of the labor force than they were in 1900. The basic structural change that has taken place in the economy since 1950 is the growth of information occupations relative to industrial occupations.

Figure 3 highlights the basic change in the structure of the economy by contrasting information occupations with all other occupations. Starting from a small base in 1950, at a level that had been virtually unchanged since the beginning of the century, information occupations grew such that by 1975 we have reached the cross-over point at which 50 per cent of the U.S. labor force is engaged in information processing occupations. How long that growth will continue before stabilizing is a major uncertainty. At its peak, industrial occupations accounted for approximately 65 per cent of the labor force. Perhaps information occupations may reach a similar peak at the height of the information age.

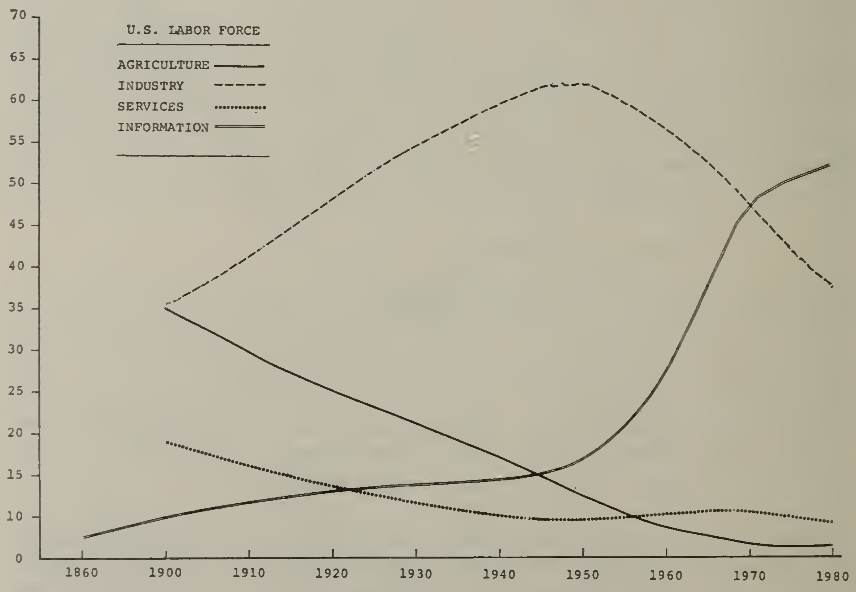

Figure 2. U.S. Labor Force: 4 Sector Aggregation

There is a certain amount of arbitrariness in the classification of occupations into information processing versus other activities. By using a more liberal or more conservative definition of what is an information-related occupation, somewhat different results would be obtained. Figure 4 highlights the effects of such definitional differences by showing both an upper and a lower bound on the percentage of the labor force engaged in information occupations between 1960 and 1980. By the more liberal definitions, information occupations accounted for more than half the labor force in 1970. By the more conservative definitions, that 50 per cent won't be reached until 1980. (Appendix A indicates which occupations are shifted by these definitional variations.) Either way, the general trend is clear.

There are other ways to characterize a society than by the distribution of occupations in the labor force. One way is to look at the annual Gross National Product or the annual National Income and see what percentage (in units of dollars or other national currency) can be attributed to the agricultural, industrial, services or information sector of the economy. Fritz Machlup, in his book, "The Production and Distribution of Knowledge in the United States" (Machlup, 1962), examined U.S. national income accounts for the year 1958 and concluded that, by 1958, 30 per cent of the U.S. economy was devoted to the production and distribution of information. He also projected a rate of growth in the information sector much faster than other sectors of the economy, consistent with the trends in information occupations described above.

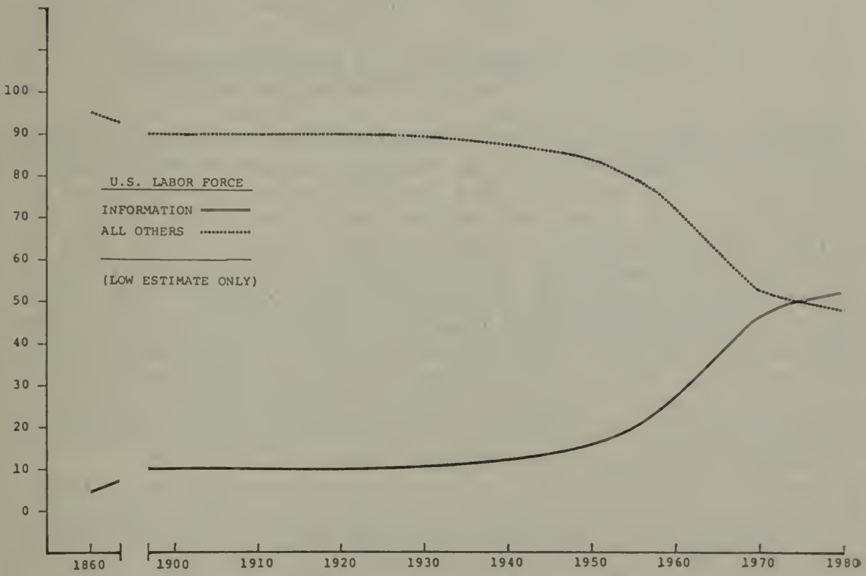

Figure 3. U.S. Labor Force: 2 Sector Aggregation.

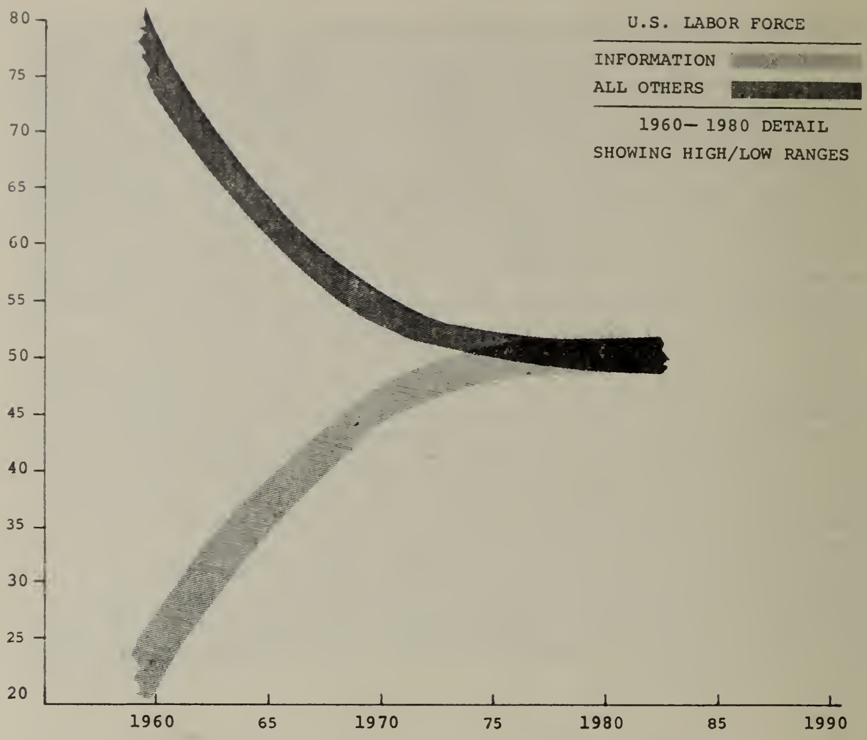

Figure 4. U.S. Labor Force: 2 Sector Aggregation. Detail 1960— 1980 Showing High-Low Range.

The U.S. society has also been characterized as becoming a 'leisure society' in which shorter working weeks and longer holidays lead to an increased focus on leisure and consumption activities relative to work activities. A closer look at the distribution of personal consumption expenditures can provide another indication of the kind of society the U.S. is becoming. In the period from 1950 to 1971, the personal consumption expenditures declined slightly (by 5.7 per cent) relative to the Gross National Product. In that same 21-year period the amount of personal consumption allocated to information goods and services increased by 39 per cent.[2] Information goods and services were defined as: telephone, telegraph, private education, books, magazines, radio, TV, motion pictures, theatre and personal business such as legal, financial and counseling services.

Whether we look at trends in the distribution of the labor force, trends in the components of the National Income, or the trends in personal consumption, the same answer is obtained: The U.S. society is in the midst of a transition from an industrial society to an information society.

We can speculate about why the past 25 years have been characterized by this explosive growth in information activities. The primary reason may be the underlying technology of computers, transitors, integrated circuits, etc. The great reduction in the unit costs of information products and services as a result of these technological changes has led to a greater demand for information products and services both as final products (consumption items) and as intermediate products useful in the production of other goods and services (e.g. computer services within other businesses). The lower unit costs for information processing have made possible new kinds of activities not previously possible or economically viable. Hence the lowering of unit costs has led to increases in expenditure on information.

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[2] See U.S. Bureau of Economic Analysis, "The National Income and Product Accounts of the United States, 1929–1965," Tables 521 and 522. Also "Survey of Current Business," July 1973.

A second reason may be the satiation or leveling off of some physical needs with a consequent shift in new demand to concern with style, atmosphere or other intangible (i.e., information-related) attributes of consumption, or a direct shift in demand to information products and services.

A third reason may be increased recognition of the value of information for production. An extensively educated (i.e., information-rich) labor force may lead to more efficient production. Extensive social investment in research and development activities (i.e., the production of new information) may also lead to more efficient production.

A fourth reason may be increased use of information because of market inefficiencies. For example, expenditures on advertising may contribute little value to the advertised products. Production might be more efficient in some industries and profits correspondingly higher if all the competitors in the industry reduced their advertising budget. But if one competitor advertises, he may gain relative to the competition. The result may be that all surviving competitors must maintain sizeable advertising expenditures, even though the expenditure is inefficient from the perspective of the industry as a whole. Some expenditure for education may be of this sort. For example, if employers screen job applicants according to educational level, even though the education is not required to do the job, then job applicants may be forced to invest in excess education in order to compete for the job (Spence, 1972).

ECONOMICS OF INFORMATION

At this point in the argument a critic or a skeptic may concede that the U.S. is becoming a society that reasonably can be labelled or defined as an information society. But he might well question the as yet untested hypothesis that the structural shift to an information society underlies the current economic problems. The critic may say, "So what? Can't information be dealt with in the economic system as a commodity like other commodities?" I argue that the answer is clearly, "No." But to understand why, a better definition of information is needed.

We need to distinguish between information on the one hand and energy or materials (matter-energy) on the other. Information is the pattern or shape or order that is imposed on or detected in matter-energy. Information and matter-energy come as a joint product, even though we analytically distinguish between the two. When we observe the pattern or shape of matter or detect variations in the flow of energy, we are receiving information. Even when the 'commodity' we value is pure information, there always must be some minimum amount of matter or energy flow on which the pattern is carried. For example, a microfilm copy of a newspaper uses less matter than the print on paper version, even though the relevant information content is the same. The enrgy consumed by a pocket electronic calculator may be less than the energy consumed by a large electro-mechanical calculator doing the same calculation, even though the same answer is obtained.

The recent rapid growth of what we have been calling the information sector of the economy is primarily in information goods and services that can be dealt with like other economic goods and services. Books, records, radios, and computers can be bought and sold like shoes, apples and washing machines. The personal services of a lawyer or psychiatrist can be purchased like the personal services of a barber or cook. Because information is a joint product with some amount of matter-energy, it is possible in many cases to buy and sell the matter-energy (the marker) on which the information is carried.

Information as such is not a commodity that can be readily bought and sold. We don't have satisfactory units for measuring quantities of information, or for establishing a price per unit. Physical commodities have the property that when one person gives or sells them to another, the original owner gives up possession. This is not true for information, because the seller or giver of information retains the information after he has transmitted it to someone else. Sometimes the value of the information to the original possessor is increased after it is widely disseminated. Scientific or artistic works often have this property.

Because information isn't a commodity like other commodities, and thus doesn't fit within our economic theories, we have created legislation that attempts by legal fiat to create property rights in information. Four areas of law are involved: patents, copyright, trade secrets, and privacy. In the case of patent and copyright laws, an attempt has been made to facilitate widespread distribution of information while still retaining the property rights of the owner who benefits from receiving license or royalty fees from other users. In the case of trade secrets and privacy laws, an attempt has been made to restrict distribution of information which is more valuable to the owner if not disseminated. But ownership of information based on the analogy of ownership of physical goods remains a forced analogy. It is not surprising that there are continuing problems with these four areas of law attempting in different ways to make a commodity out of something that is not a commodity, especially at a time when information technology is rapidly changing.

According to neoclassical economic theory and conventional wisdom in economic policy, the production and distribution of physical commodities can best be handled within a competitive economic system. When all the assumptions of the economic theory are met, then unrestricted competition should lead to optimal total investment (even if the distribution of benefits from that investment offends our social consciences). But one of the key assumptions of the economic theory leading to that conclusion is the assumption of standardized products about which consumers have perfect information. This leads to impossible contradictions in the case of information treated as a commodity. If the buyer has perfect information about the information he is considering buying, he has no need to buy it. In addition, the seller can't relinquish possession of the information because he still has it after the transaction. Consequently, cooperative rather than competitive strategies are more appropriate to information. The total gains to the society are likely to be greater under cooperation than under competition. Unfortunately, we don't have completely satisfactory mechanisms for such cooperation. In a competitive society, some possible forms of cooperation may come under legal attack as anti-competitive practices subject to legal action under anti-trust legislation.

The distribution of information has a declining marginal cost, that is the cost of providing the information to the n'th user once the information has been produced and distributed to the previous users is small relative to the earlier costs. What is the cost of providing a library book on loan to the 25th user, when its purchase was already paid for? What is the cost of adding one more member to a radio or television audience that already may number in the millions? These declining marginal cost problems make it very difficult to create appropriate incentives for the original production of information.

Some conclude from these considerations that information is a public good like other public goods such as roads and police services. Some information goods and services, for example most schools, libraries and scientific research, are already treated as public goods which require governmental support. Calling it a public goods doesn't solve the policy questions, however. That just affirms that many of the relevant investment and allocation decisions have to be made collectively, presumably through governmental decision processess. Calling information a public good doesn't solve the vexing social policy questions of how much to invest in what kinds of information production and distribution. Since there are no economic units in which to measure quantities of information, the question of how much information can be bought for a given amount of money is a meaningless question. And since information is not a standard commodity, the question of what kind of information is a crucial value question. In the case of production of information (e.g. research), as distinguished from distribution of information (e.g. education), there's the further difficulty that we can't know in advance what information will be produced.

There is now an exciting and growing sub-area of economic theory concerned with the economics of information, stimulated by Kenneth Arrow and others (Arrow, 1974; Spence, 1974; Hirschleifer, 1973). So far, these economists of information have been able to show that an absence of collective decision-making with respect to information leads to non-optimal economic results. But they haven't yet provided clear policy guidance concerning what an effective information policy should be.

As the information sector of the economies of developed societies continues to grow, these problems will become more and more difficult. As the cost of the matter-energy component of information (the markers on which information is stored and transmited) continues to decline relative to the cost (primarily intellectual labor) of providing the information itself, the competitive market place will become less and less effective as an efficient allocator of investment resources.

Now we can return to my hypothesis that the structural shift from an industrial society to an information society underlies many of the current economic problems. One part of the problem is the physical resource constraints limiting or restricting economic growth in conventional ways. The other is the absence of automatic mechanisms for providing efficient investment in the growing information sector of the economy. The twin problems of stagnation in the traditional sectors and inefficient investment in the growing sector will require major policy analysis in the next several years. As we saw in the U.S. data presented earlier, the U.S. is already far advanced in the transition. Given the present international interdependencies, the resulting U.S. problems are affecting other economies also. And other economies following the same path as the U.S. may be beginning to suffer from similar problems in their own right, depending on how far into the transition stage they have advanced.

NATIONAL ECONOMIC POLICY QUESTIONS

It may prove fruitful to re-examine key areas of economic policy problems in the light of this hypothesis concerning structural change in the economy. Although the questions are inter-related, I have singled out for discussion the following four topics: productivity, natural resource constraints, inflation, and international interdependence. Even if my major hypothesis is later shown to be at least partly false, much of the analysis of the specific problems may still be relevant.

A. Productivity

At a time of economic recession, with or without inflation, a key question has to be how to stimulate economic growth. In the United States the fastest recent economic growth seemed to coincide with the peak of the industrial age. As we began the shift into the information age the companies that grew the most rapidly were those with information processing products, for example IBM and Xerox. Economic productivity gains were achieved in the industrial sector of the society, including those making information machines. But as the percentage of the economy devoted to manufacturing declined, the rate of economic growth has slowed. Most observers agree that the primary source of productivity gains is information—information in the form of education for a more highly skilled labor force, and information in the form of research and development leading to more efficient products and production techniques. When the information sector of the economy was small relative to the industrial sector, increased expenditure on information apparently paid off. Now that the information sector of the economy is larger than the industrial sector, that strategy may be reaching a point of diminishing return. One U.S. observer (Pake, 1971) points to declining productivity in the U.S. universities, citing costs per unit of instruction increasing by a factor of four in the decade of the 1960s. Although this is extreme rather than typical of costs of information services, it is still easy to see that declining productivity in the information sector could offset any productivity gains in industry at a time when the information sector is larger than the industrial sector. Despite the introduction of information machines, the information sector of the economy (including education and most of government) is strongly labor-intensive. If information sector wages are set at levels consistent with productivity gains in industry without corresponding productivity gains in the information sector, then the advantages of productivity gains in the smaller industrial sector may be nullified.

At a time when the information sector of the economy is the largest and fastest growing sector, and when information technology is a cost-declining technology providing opportunities for productivity gains, it may be counter-productive for governments to pump more and more money into labor-intensive information activities with declining productivity. More of the same, even though it apaprently worked to achieve productivity gains in the period when the information sector was smaller, may now lead to the opposite of the intended effect. Now, instead of looking for productivity gains in the agricultural and industrial sectors by pumping more money directly into the information sector, governments could instead implement policies that would stimulate productivity gains in the information sector itself.

Since the information sector of western industrial societies is largely dominated by government (including most of education), government policies will be required to obtain productivity gains in this sector. The traditional incentives for the private sector to introduce new practices leading to productivity gains are absent. In any case the lack of easy appropriability of information and consequent under-incentive for the private sector to produce it was what led many governments to their present large involvement in the information sector of the economy in the first place. Consequently, reliance on traditional private sector incentives to produce productivity gains is likely to be futile.

B. Natural Resource Constraints

The end of the industrial age doesn't mean the end of industry, but it does mean the end of rapid growth in the consumption of energy and materials. Continued growth of the value of industrial output will require greater efficiencies so that more or better output can be obtained from available resources. To achieve greater efficiencies in production, information will need to be applied—information in the form of research and development and in the form of education. The efficiency problem now needs to be posed differently than in the past. Instead of replacing human labor with ever greater application of physical energy, a new approach is called for. Physical energy and materials may be limiting factors. Increasing the output per worker under resource constraints requires a continuing search for better techniques. We need to have our industrial production work smarter rather than just work harder.

But industrial production shouldn't be the primary focus of attention in a post-industrial age. The more promising approach to economic growth (or growth in quality of life) is to reinforce the social trend away from conspicuous consumption. We should be able to maintain present consumption levels, but effect a shift in consumer preference away from resource-intensive goods. The trend in U.S. preference toward smaller, more economical cars concurrent with greater consumer expenditures on information goods and services is an indication of this kind of shift. Can we shift consumer preference such that the average citizen will receive as much perceived utility, and hence social welfare, from a year of college education as from a new automobile? Or as much satisfaction from reading or writing a book as from acquiring material possessions? Can we learn to acquire status from the acquisition of education, mental health and the ability to process complex information instead of ever increasing quantities of physical consumption? Can the 'Protestant Ethic' of the industrial age be shifted in the information age such that ideas and not things become the object of much of our labor? Can we evolve beyond the basic biological drive for physical and material security and develop a desire for self-actualization?

Many of these trends are happening anyway, but government policies could ease the transition. For example, commercial advertising intended to stimulate consumption of energy and materials could be taxed more heavily than advertising intended to shift consumption to products and services requiring less energy and materials. And government policies could shift the focus of search for productivity gains from the resource consuming industrial section to the information sector where fewer energy and materials constraints should apply.

C. Inflation/Stagflation

The problem of inflation, or worse 'stagflation' combining inflation and economic stagnation at the same time, is a topic of such current concern and debate among economists and policy makers that it is perhaps foolhardy fr a non-economist to make some necessarily oversimplified comments. But the topic is so important, that I must take the risk. Conventional remedies for inflation tend to have recessionary impact. Similarily, remedies for recession can fuel inflation. This is true whether the remedies are those of monetary policy or through fiscal policies of taxation and government expenditure. These remedies are designed primarily to act on the economy as a whole, rather than to redress structural imbalances within the economy. Policies designed to solve problems of stagflation need to be more selective in order to solve structural problems in the economy. It may be necessary to slow down those sectors of the economy that are heavily dependent on energy and materials (especially imported oil), while stimulating productivity gains and economic growth in sectors with less long-run inflationary impact and fewer balance of payments problems.

Shifting more money into the information sector of the economy to increase the amount of information services available at present levels of productivity may seem an attractive alternative, but this is not likely to reduce inflation in the long run. Salary increases in the presently labor-intensive information sector are likely to have an inflationary impact. To reduce the long-run inflationary impact of the information sector of the economy it will be necessary to make capital investments in information technologies that can stimulate the availability of more services at lower unit costs (i.e., productivity gains). Economists will quite rightly point out that such capital investment may in the short run exacerbate inflationary tendencies.

Nevertheless, such capital investment may be an essential part of the long-run solution to the problem of inflation and could be justified as part of a fiscal policy aimed at the twin problem of recession. Alternately, a technique like inflation indexing as used by the Brazilians might alleviate some of the bad effects of inflation while policies are implemented to remove the underlying structural problems.

One way in which information technologies might help to reduce inflation is to use information technology to provide economical information services that reduce market failures or inefficiencies and reduce transaction costs in other parts of the economy. According to economic theorists, economies work best when all consumers have perfect information about the products available and the prices offered by different producers and when producers have perfect information about the preferences of consumers and the prices they are willing to pay. In simple economies with a small number of relatively standard products the incidence of market failures through inadequate information may have been smaller. Now, in our increasingly complex societies with a bewildering array of choices, we often pay more than we need to for goods and services because we don't have sufficient information. Many of us may contribute to inflation by our own purchasing behavior because we have inadequate consumer information and cannot afford to take the time necessary to acquire better information. Government could stimulate better consumer information and encourage the establishment of marketplace or brokerage functions in areas where market failures are detected. Markets for information itself are especially troublesome because of the problems in the economics of information discussed above.

D. International Interdependence

As the amount of information flowing across national boundaries continues to increase, the same considerations that apply to national policies will increasingly apply to international policies. As our information interconnections increase we need to increasingly turn away from competitive strategies and toward cooperative strategies. Cooperation is essential to information flow; without cooperation we don't develop the common symbols with shared meanings that are essential for communication. A shift away from international competition to international cooperation doesn't imply that there should be no specialization and competition in the production of goods and services. It does imply that we need to avoid the disastrous international consequences of unrestrained international competition that leads to all nations losing. For many goods and services competition within and between nations will continue to be economically sound. But as the information sector of national economies and international exchange increases, the requirements for cooperation will increase. Competition will have to take place within the boundaries of cooperative agreements. Within the economies of both Japan and Sweden, at least as they appear to the casual outside observer, it appears that successful strategies have been found to encourage economically beneficial competition with a larger cooperative framework that ensures that the competition leads to greater success for all and not just redisribution of resources. Analogous approaches may be required on an international scale. As we learn to live with global resource constraints we will need to devise strategies leading to improved quality of life for all, rather than self defeating fights to grab a disproportionate share of scarce resources.

Given the major resource interdependencies, currently typified by global dependence on oil exporting countries, there is not much of an alternative to cooperative strategies. Policies that lead to a widening of the economic gap between developed and less developed societies are likely to lead to dangerous instabilities. The old attitudes of an industrial age may force such instabilities if they are not modified to meet the new circumstances. If people think of their own self-interest in terms of material wealth in which resources one nation is using are not available to others, then exploitation or unstable competition may result. As the global economy shifts more to an information economy, then then knowledge of each society could be shared for mutual benefit, without loss to the sharing societies. As John Diebold (1973) argues in "Foreign Affairs," the best opportunity for continued economic growth of information rich societies like the United States, western Europe and Japan is to sell that information to the developing countries in exchange for natural resources. The 'know-how' that is sold to the developing countries should enable them at least partially to close the industrial gap between the present rich and poor countries—creating a more equitable and hence more stable distribution of physical wealth. The result of such an exchange would permit continued improvement in the quality of life in the presently industrialized societies at a faster rate than would otherwise be possible. This non-obvious conclusion follows from the nature of information—the more of it you share the more you have left at the end of the transaction. This is because information exchanges lead to improvements in the quality of information rather than loss of information. The information game can be played on global scale as an everybody wins game rather than the kind of winners and losers game that is played with material resources.

SOCIAL ISSUES

These economic trends and opportunities will have consequences and side effects that will be perceived as social or political.

A. Information is Power

There seems to be a certain validity in the claim that 'information is power.' The difference between George Orwell's 1984 and a hypothetical participatory democracy with widespread sharing of political power lies in the question of who controls the sending and receiving of information in the society. Information policies that cater to an information elite and serve to widen the gap between the information-rich and the information-poor may have short-run advantages to elites already in power. But they would have the effect of limiting economic growth and the effect of risking political upheaval by exacerbating inequities of political power.

Some proposals put forward in the name of distributing political power, especially electronic referenda proposals, may have the opposite of the claimed effect and lead to increased opportunities for demagoguery and manipulation (Parker, 1972). The real opportunity for wider participation lies in the issue of access.

Lowered technical costs associated with the manipulation, storage, transmission and reception of information will make it economically possible for near universal access to the information resources of the society. Communication costs via satellites and some computer networks are independent of distance, thus potentially reducing disparities between the geographic power centers and their peripheries. Computer information retrieval systems can make it possible for any citizen to have access to stored information without expensive labor costs of access. Specific items of information being sought could be made accessible on demand without sorting through libraries full of paper. Low cost audio and video technologies can permit citizen access to the sending as well as the receiving ends of audio and video channels.

Elites currently in control of information channels may feel threatened by the political pressures that will build up behind arguments for access. In principle, in western democracies at least, equality of opportunity and equitable access to information channels (e.g., freedom of speech) are accepted as desirable goals. An informed electorate is more likely to lead to good government, we're told. The economic advantages to a society of widespread access to public information may be sufficient to enforce these ideals in practice in the long run. In the short run, those elites who see their own political and economic power being diluted through greater social access to information may fight a strong political rear-guard action.

A short run effect of introduction of new information technologies is to widen the gap between the information-rich and the information-poor because the rich and the well-educated are the first to obtain access to the new services and benefits. In the long run, after the benefits are widely diffused through the society, everyone may be better off. That is, unless there is a constant flow of new innovations that always leave the information-poor with the previous technologies. An excellent discussion of this problem is provided by Katzman (1974). These considerations may lead some societies to defer or delay implementation of new information services until social and economic policies can be devised to make the benefits available to the entire society and not just the elite segments of the society.

B. Privacy

The opposite side of the coin from access is privacy. What is seen by some groups as legitimate access to information may be seen by others as unwarranted invasion of privacy. As the costs of access to information continue to decline and new information technologies become more widely available, new pressures and new abuses will inevitably occur. In situations of unequal access to information (for example, when large corporations or governmental units have data banks of information about individual citizens who in turn have difficulty finding out about the inner workings of the corporation or governmental unit), the weaker power (the citizen) may have to assert a right of privacy to avoid exploitation. On the other hand, partial redress of the imbalance may be possible through the opposite strategy of making the corporate and governmental information more accessible and hence more vulnerable to political or social pressure. These will be tricky issues for governments to deal with as our societies make the transition from the industrial age to the information age.

C. Property Rights in Information

The issue of property rights in information (copyright, patents, trade secrets) is likely to be difficult. The difficulty in protecting 'ownership' of computer programs through either copyright or patent protection may be serious because there may be insufficient incentives to produce and share computer 'software' on an economically efficient scale. These laws attempting to create property rights in information and thereby create artificial incentives to stimulate the production of information may be ineffective or inefficient. As long as the rest of the economic system is geared to the production and distribution of physical goods, ad hoc legal arrangements will be necessary to make information more or less fit that kind of economic system.[3]

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[3] Eventually, economic theorists may be able to devise an economic theory appropriate to the information age, presumably a theory supporting an ideology of cooperation rather than an ideology of competition, and ways may need to be found to bring about a transition to a different type of economy. In such an economic system, different legal arrange-

(Continued)

D. Work and Leisure

The shift to an information society is changing the distribution of occupations, as the data presented earlier indicated. Perhaps not so obvious is a possible shift in the distinction between work and leisure. Men and women are information processing animals. It is our information processing capability that distinguishes us from other animals. The distinction between production and consumption is harder to maintain when the activity is information processing. When we talk on the telephone we are both producing and consuming information. People in managerial, clerical, or other information related jobs both produce and consume information as part of their work. Most of us are information consumers in our leisure, whether watching television, or football, or reading a book. Before the age of mass media a higher proportion of leisure activity was production rather than consumption of information—with people engaged in group singing or storytelling, for example. Now that the costs of machines for production as well as consumption of information are declining, there is more use of photography, home-recorded audio cassettes, and the beginnings of amateur use of videotape technology. With lower costs and a more affluent and more educated population, production of information is growing as a leisure activity.

Many people in information processing jobs requiring responsibility and originality enjoy their work not just because of the financial rewards but because of the intrinsic pleasure of their work. No longer should we distinguish between work and leisure on the assumption that work is painful or stressful and leisure is fun. There are growing numbers of us who like our work and choose our jobs not on the basis of financial reward, but on the basis of intrinsic job satisfaction. Our work is fun and we spend long hours at it because we enjoy it. We may be in a small minority now, but the trend is now upward as we go beyond the alienating assembly-line work style typical of the late industrial age.

Before the industrial revolution many 'industries' were cottage industries with people working in their own home. In an information age it may be desirable to partially return to a style of work at home for many information occupations. When computer terminals and computer networks are as accessible to every home as telephones and the cost of word processing on computer terminals with electronic storage is cheaper than word processing on typewriters with paper storage, then many people in word processing occupations will work from home the way many computer programers in the United States now work from home using portable computer terminals and telephone connections. The cost in money, time and consumption of natural resources required to commute to and from the office from a distant residence every work day is considerable when summed across all commuters With sufficiently cheap electronic communication, significant reductions in oil consumption are possible.

For the immediate future we'll see small blurrings of the distinction between work and leisure, home and office. In the more distant future that we don't have to worry about yet, we may find that we can some-

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(Continued)
ments may need to be found to efficiently handle production and distribution of physical goods. But such problems are for the far distant future. For the foreseeable future, the legal and political problems will be those of trying to make information more or less fit an economic system designed for physical commodities.

what decouple the physical reward system from the workplace and provide all citizens with the minimum of food, clothing and shelter needed to meet their physical needs, whether or not they work in the usual sense of the term. The rewards that drive a fully developed information economy may be intrinsic satisfaction and a kind cooperative barter economy in information such that exchanging information is not a direct economic transaction. We may pay a flat or metered rate for the use of the communication network itself (like a monthly telephone rate permitting unlimited calls or an electric utility rate based on kilowatts consumed). Information travelling over that network then may be exchanged freely, just as in most telephone conversation today. Meanwhile, for the present, policies still will be required to facilitate the sale of information without incurring unduly high transaction costs.

APPLICATION AREAS

The policy implications and policy questions associated with computer/telecommunications technology will emerge in a variety of different applications areas of concern to governments.

A. *Education*

Governments already influence the productivity gains or losses in the information sector of national economies through their education policy. If almost all government expenditures for education are for construction of buildings or for current operating expenses, then productivity gains are extremely unlikely if not impossible. Capital investment in less labor-intensive technologies with cost-declining characteristic will be necessary to achieve economic productivity gains in education. Shifts to use of video textbooks and computer instructional techniquest could permit lower unit costs (after appropriate research and development has taken place and an economic national infrastructure for such services is in place). Without the development of instructional techniques with lower unit costs (e.g., through Open Universities or other institutional innovations), it is unlikely that any of our countries could afford to provide open access to lifelong learning opportunities for all its citizens. Yet both national economic policies and social policies seem to be creating pressures in the direction of just such extended learning opportunities for all citizens.

If new information technology is added to existing educational institutions without either decreasing the investment in building construction or teacher salaries, or increasing the number of students, then unit costs will obviously be higher rather than lower. On the other hand, if new investment in information technology for education is justified solely on the basis of saving labor costs, the political pressure from teacher organizations may be strong enough to block reform. One answer to his dilemma may be to experiment with new technology-intensive education techniques for extending educational services to those members of society not now being served by present educational institutions.

The Canadian Department of Communication, through its Educational Technology Program, is experimenting with new uses of computers, audio-visual technology, and telecommunications systems for education. In the United States, a new Consortium of users of educational television was formed in December of 1974 to purchase or lease operational services from a high-powered communications satellite that could distribute television nation-wide to ground receivers costing less than $10,000 each. The operational satellite is expected to reduce video distribution costs (including administrative costs and videotape inventories) below those incurred in shipping videotapes by mail. At the same time the satellite will permit instructional television service to remote areas (e.g. in remote Alaska villages) not now served by television at all. This a logical sequel to current experiments will instructional television distribution via an experimental communication satellite soon to be moved to India for use there. Those of you more familiar with the European, Japanese or Australia experience could doubtless add many other examples.

B. Funds Transfer

Electronic funds transfer or credit checking applications are now being implemented or seriously considered. The cost savings over present methods of funds transfer based on checks and paper is likely to push this application quickly. Transfer between financial institutions and between large businesses and financial institutions will likely lead to interconnections at retail points of sale. Hence, a nationally (and internationally?) interconnected computer network reaching infrastructure in support of such applications especially if the same infrastructure can support other applications also.

As in any change in systems and procedures, there will be inevitable adjustment problems. The reduction in "float" may cause one such adjustment problem when people and institutions can no longer count on a few days between the time of writing a check and having it cashed.

The social disadvantages of such a system may be more than temporary problems of adjustment, however. Some responsible and knowledgeable computer professionals are urging that such a system never be implemented. Their reason is that it would create a complete electronic record of the financial transactions of all members of society and permit invasion of privacy, surveillance, and violation of civil rights on an unprecedented scale. If policy decisions are made to proceed with such systems, then careful attention will need to be paid to the safeguards required to keep such systems from leading to morally repugnant systems of social control.

C. Facilitating Trade

One example of the use of computer/telecommunication technology to facilitate trade is the Canadian Organization for the Simplification of Trade Procedures (COSTPRO). The 1974 COSTPRO president's report comments that their initial work offers its users up to 70 per cent reduction in paperwork costs associated with Canadian exports. It reports that unnecessary delays due to documentation and procedures occur on 20 to 25 per cent of all shipments, that a reduction in total transaction time of one day could produce savings in interest on capital invested in excess of $10 million per year, and that elimination of one particular document could alone save $80 million each year.

At every level of trade from large scale international import-export trade to local retail trade there are likely to be opportunities for improving the efficiency of trade. Economic theorists agree that markets operate better when buyers and sellers have complete information. Absence of information is considered a serious market imperfection that results in a less than optimum result overall. Government intervention may be required to facilitate orderly and honest development of market information and brokerage services based on new information technology. Policies that encourage appropriate information standards, interconnection of communication hardware, access of service vendors to hardware networks, and cooperative directories of services may be desirable. Some waiver of anti-trust laws or government participation may be needed to permit the industry cooperation essential to common information directory and brokerage services.

D. Consumer Information

A logical extension of systems to improve funds transfer and facilitate trade would be consumer information systems. Even though some individual manufacturers might oppose the extension of the consumer movement to include accurate product and price information made readily available to most consumers, nevertheless, the industry and the economy as a whole are likely to benefit from such services, as will individual consumers. Computer terminals available in libraries or other public places providing access to up-to-date on-line directories of products and services available for consumers could prove to be a valuable social service.

E. Public Administration

The business of government is largely information processing and decision-making. Use of computer communication techniques may be the best hope for improved efficiency and productivity in government. OECD has already devoted special effort to studying this issue and has reported on it in the recent document "Automated Information Management in Public Administration." (OECD, 1973). Education and government are the two largest components within the information sector of post-industrial societies. If our societies are not to stagnate economically, these components of our economies must find a way to avoid inflationary increases in the unit costs of the public services provided. Technology will not provide a panacea and transition problems will be difficult. The prime potential of the new technology might not be in cost reductions for existing services, but in the rational reorganization of bureaucracies that may become politically possible at a time of adapting to new technologies.

F. Teleconferencing

U.S. experience has shown that fully switched point to point two-way video service is still extremely expensive and, in the opinion of most potential customers, not worth the cost. Nevertheless, there are more reasonable alternatives to videophones for teleconferencing applications. The most promising alternative is a capability providing a combination of voice and data capability for group conferences. Such capabilities are unlikely to substitute for face-to-face meetings that occur infrequently and in which one of the purposes is for participants to meet and get to know each other better. But for more frequently occurring conferences (e.g., weekly or monthly sales meetings) among people who already know each other, the demand for such services, if offered, is likely to be great because of the potential savings in travel time and costs.

Telephone conference calls of the sort now available are unsatisfactory for a variety of reasons. The prime disadvantage of telephone conferences over face-to-face conferences is the lack of a parallel scheduling channel for signals to and from the chairman concurrently with the primary discussion. In fact-to-face conferences this usually goes on through visual signals or passing of written messages that do not interrupt the flow of conversation. With a computer communications channel parallelling the voice channel, a variety of control and signalling messages as well as drafts of documents being discussed can be distributed to some or all participants in the conference. For such a teleconferencing system to work smoothly, it will require an automatic dialing capability that doesn't require telephone operator intervention and that permits participants to dial additional potential participants while the conference is in progress.

G. Health

Health care, except for surgery and physical therapy, is largely an information processing activity in which the health care provider obtains information from the patient to arrive at a diagnosis and treatment plan based on his store of information about diseases and their treatment. Medical information systems can facilitate many parts of this process. Examples include: automated patient record systems, on-line access by providers to medical research literature, drug information (including side-effects and interaction with other drugs), poison information, teleconsultation between patients and providers geographically distant from one another, etc.

A promising potential application may be in the area of preventive community medicine. Many of our serious medical problems (e.g., heart disease and cancer) stem from our diets, our smoking and our lack of appropriate exercise. A community based nutrition information system which allowed each resident access (probably via a human interpreter at the end of a telephone) to nutrition information in a form relevant to his or her shopping, menu planning, and recipe decisions could make a significant difference to the level of health. A recent study in California has demonstrated that an intensive public information campaign can reduce the incidence of heart disease through triggering changes in diet, exercise and smoking behavior, that result in measurable differences in levels of cholesterol and triglicerides in a random sample of community residents. Savings in total health care costs and savings to insurance companies that result from increased life spans might be sufficient to economically justify a sizeable share of the costs of continuing public information services concerning health and nutrition.

For example, computers could store general nutrition information at a level more detailed than a dietician would normally try to explain in a face-to-face consultation. That information could be applied to a variety of recipes designed for different health goals (e.g., weight loss, reduction of cholesterol), different food budgets, and different taste preferences. Local availability and prices for ingredients could be included in the information system so that recipes and menus are in fact responsive to current local availability and costs. If desired, individual medical records and the results of a food preference questionnaire could be included in the information system and taken into account in the resulting advice.

Local users could telephone a local nutrition information number, reaching a clerk who could conduct the on-line computer search necessary to retrieve the relevant information. The savings to the consumer resulting from more economical food shopping may be a major source of motivation to use such a system. In some ways, such a consumer-oriented health information system could be viewed as one segment of a larger consumer information system.

CONCLUSIONS

In conclusion I would like to suggest a few policy questions that I think should be considered in the light of the structural change our economies are going through and in the light of changes in computer and telecommunications technology.

A. Research and policy analysis

The first conclusion points to the need for research and policy analysis of the kinds of questions and hypotheses raised in this paper. The data presented here are crude first approximations that are descriptively consistent with the hypothesis of structural change. What is needed now is a program of economic research that develops, refines and validates new indicators of economic statistics appropriate to an information economy so we can better understand what is happening.

The now standard industrial economic indicator, Gross National Product (GNP) was introduced in the late 1940s just before the peak of the industrial age in 1950. New economic indicators and statistics appropriate to the policy problems of the information age should be devised and implemented now so that policy makers can better understand current economic trends.

Once the descriptive indicators are sharpened, and appropriate basic economic data have been tabulated, then a series of economic input-output analyses should be conducted to measure the relationship of the information sector of the economy to other sectors. For example, input-output analysis could determine the structural depth of the information sector to see, if, as I predict, it is of sufficient depth that changes there will reverberate through the entire economy. Secondly, looking at the input-output relationship between the information sector and other sectors (e.g. energy) could determine whether it is possible to have major economic growth in the economy as a whole, under the constraint of zero or limited energy growth, through appropriate investments in the information sector. These and other policy questions are open to scientific empirical analysis with presently available economic research tools and techniques. A major program of research along these lines should provide considerable assistance to policy makers trying to chart their way through unfamiliar territory.

B. Infrastructure

The greatest economic potential of computers and communications lies not in the share of the economy devoted to those activities (although it is likely to be large enough to merit attention on that basis alone). Rather, the greatest potential lies in the effects on the rest of the economy. Transportation networks and electric utilities provide a basic infrastructure permitting the economic development of new geographic regions, the development of new industries and services, and permitting the goods and services of one region to be accessible in another. Similarly, computer-communication facilities now being discussed, but not yet constructed, could serve as basic infrastructure for information economies.

If the social and economic benefits of the information society are to be achieved, then policies for development of an appropriate infrastructure need to be articulated and implemented. The applications discussed above are examples of a wide new range of information services that are developed once the infrastructure is there to permit the services to be implemented. It makes a great difference to the economic development of a country whether a communication network (or new nodes on the network) are treated as essential infrastructure needed for development or whether it is treated as a consumption or luxury item to be provided only after the demand is great. In the latter case, development will be slow, uneven, and probably inequitably distributed. Social policies designed to stimulate economic growth of the information sector of the economy will require policies that lead to creation of the needed infrastructure, just as government policies and investment support were needed to create railroad, highway, and electric power networks to serve industrial society. Social policy may require that the network be made available everywhere in the nation, not just in the large cities or on the main routes between the largest cities. Communication technologies with costs independent of distance may make such policy choices easier than physical transportation networks for which costs are a function of distance.

My conclusion is not to recommend a specific set of policies with respect to the development of computer-communications infrastructure. Instead, it is a conclusion that the policy decisions concerning such development (or postponement of development) should be made as a major national economic policy decision, not as a minor decision to be made within a telecommunications administration or a monopoly common carrier.

C. Research and Development

The peculiar economic nature of information makes it unlikely that the private sector of our economies will automatically generate optimal (i.e., economically efficient) amounts of capital for research and development of new services. The problem is analogous to the reasons behind the institution of copyright and patent laws and the reasons why governments already supply most of the basic research funds in a society. Given the kinds of economic systems we have, there is insufficient incentive for private expenditure on research and development of information services. Therefore, government research policies should be carefully examined to see if appropriate investments are being made in the kinds of research, development and demonstration projects needed to achieve productivity gains in the information sector of our economies.

D. Network Interconnection

Much of the economic and social potential of the new services we have been discussing will be dissipated if each service is developed on a private or leased line computer network or if it is dependent on telephone networks as they are now structured.

Use of line switching techniques suitable for telephone conversations will be economically inefficient for time-shared data transmission with the kind of long hold-times and long silences involved. A time-shared digital data network with redundant channels and error-checking procedures will be required. Even if the transmission lines use analog techniques, packet-switching techniques could be used for digital communication.

If each new service is developed on a separate computer network or series of disconnected networks, then most of the benefit will be lost because only those services with sufficient economic potential to justify their own network will appear. On the other hand, if a single generalized network or network interconnection system is required, then many new information services can be developed that require only a small portion of the network capability.

Since there is likely to be continued technological change in the area of computer communication, a more modular approach to multiple interconnected networks with common interconnection standards and a payments clearinghouse mechanism may be preferable to a monolithic single network, which would have a tendency to stifle technical innovation.

E. Access

The single most critical policy question concerns rights of access to information networks for both the transmission and the receipt of information. Individuals and groups within the society may find it in their narrow interest to restrict access. In the interests of economic growth and of social equity, principles of freedom of access to information networks need to be established. Information networks have common carrier and public utility characteristics similar to other comman carriers or public utilities. The information networks of the information society will have to be open to all if the potential social benefits are to be achieved.

Monopoly ownership of the hardware facilities does not preclude open access to the facility for transmission of messages. Just as telephones can be available for people to speak what they wish, so other parts of the computer and communication infrastructure must be accessible. If those owning or operating the hardware facilities of the information society are able to restrict access on the basis of selfish political or economic motives, then it would be better not to construct such facilities at all. Unless principles of open access to the information facilities are firmly established at the outset, then the path of development of such facilities is the path toward the worst features of Orwell's 1984. If the control is vested in the hands of commercial operators, then the results could be as bad as or worse than the society depicted by Orwell. The issue is not who owns or operates the hardware facilities. The issue is whether the facilities, however owned, are in fact accessible for use by all members of the society.

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APPENDIX A

THE LABOR FORCE AGGREGATION SCHEME

The aggregation scheme presented below formed the basis of Figures 1–4 in the paper. The category names are those used by the U.S. Bureau of Labor Statistics.*

The basic four-sector aggregation scheme divides the workforce into: (i) information workers (ii) industry workers (iii) services workers and (iv) agriculture workers.

The table contains simple legend between the name and the number employed in these occupations in 1970. Figure 1 in the paper shows three sectors only (agriculture, industry, and services). A "letter" in the space following the name indicates that, when the four sector scheme is collapsed into a three sector scheme, the labor type in question is shifted, as follows:

s: indicates a shift into the service sector.
i: indicates a shift into the industry sector.
a: indicates a shift into the agriculture sector.

Also, we use the asterisk * to indicate that under *liberal* assumption (see text, and figure 4 in particular), the worker would be classified into the information sector; but under the prevailing *conservative* assumptions, the worker was not so classified.

All data are for 1970, taken from BLS publications.**

INFORMATION SECTOR OCCUPATIONS

Occupational type	Legend	1970 employment
Authors	s	26, 003
Editors and reporters	s	149, 998
Proofreaders	s	26, 999
Radio, TV announcers	s	21, 000
Writers, artists, entertainers	s	70, 004
Librarians	s	115, 003
Library attendants, assistant	s	120, 008
Postmasters and mail supervisors	s	34, 999
Newsboys	s	71, 997
Mail carriers, post office	s	267, 995
Postal clerks	s	314, 995

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*For full definitions of the labor types, including description of the work, see Bureau of Labor Statistics (BLS) *Handbook of Occupational Types,* Volumes I and II, Government Printing Office, Washington, D.C.

**These are based in turn, on the U.S. Census "Industry by Occupation" Special Report, 1970 Census. Available through the Government Printing Office, Washington, D.C.

INFORMATION SECTOR OCCUPATIONS—Continued

Occupational type	Legend	1970 employment
Telegraph:		
Messengers	s	2,500
Operators	s	12,000
Do	s	388,008
ineers:		
Aeroastronautic	s	60,999
Chemical	s	49,999
Civil	s	167,003
Electrical	s	280,997
Industrial	s	159,006
Mechanical	s	184,995
Metallurgical	s	15,003
Mining	s	5,001
Petroleum	s	12,000
Sales	s	38,998
Other	s	130,005
Agricultural scientists	s	13,001
Atmospheric, space scientists	s	6,000
Biological scientists	s	29,003
Chemists	s	109,004
Geologists	s	24,001
Marine scientists	s	3,001
Physicists and astronomers	s	21,002
Life, physical scientists	s	2,001
Actuaries	s	5,000
Mathematicians	s	8,001
Statisticians	s	21,003
Draftsmen	s	316,007
Surveyors	s	59,001
Radio operators	s	30,001
Tool programers, numerical	s	3,002
Computer programers	s	176,506
Computer systems analysts	s	88,103
Other computer specialists	s	14,601
Economists	s	66,006
Political scientists	s	1,900
Psychologists	s	30,002
Sociologists	s	1,303
Urban and regional planners	s	9,000
Other social scientists	s	7,000
Adult education teachers	s	58,003
Agriculture teachers	s	5,000
Art, drama, music teachers	s	30,001
Atmospheric, earth, marine	s	4,500
Biology teachers	s	21,000
Business, commerce teachers	s	14,000
Chemistry teachers	s	16,000
Economic teachers	s	10,000
Education teachers	s	7,200
Elementary school teachers	s	1,400,040
Engineering teachers	s	17,000
English teachers	s	39.001
Foreign language teachers	s	20,700
Health specialites teachers	s	28,000
History teachers	s	16,000
Home economics teachers	s	4,200
Law teachers	s	2,900
Mathematics teachers	s	26.000
Physics teachers	s	14,000
Preschool, kindergarten	s	133,004
Psychology teachers	s	13,000
Secondary school teachers	s	1,037,029
Sociology teachers	s	7,000
Social science teachers	s	12,000
Miscellaneous college and university	s	19,000
College, university	s	148,004
Theology teachers	s	5,000
Trade, industrial teachers	s	3,000
Teachers, excluding college and university	s	209,912
Photographers	s	70,196
Public relations men, writers	s	82,007
Accountants	s	686,015
Architects	s	62,002
Architects and curators	s	6,002
Home management advisors	s	5.202
Judges	s	13,700
Lawyers	s	287,013
Operations, systems research	s	79,005
Personnel labor relations	s	286,011
Research workers	s	115,004
Social workers	s	230,007
Vocational, education counselors	s	112,003
Bank, financial managers	s	398,010
Creditmen	s	67,998

INDUSTRY SECTOR OCCUPATIONS—Continued

Occupational type	Legend	1970 employment
Buyers, shippers, farm products	s	24,999
Buyers, wholesale, retail	s	154,998
Purchasing agents, buyers	s	175,006
Sales manager, retail trade	s	274,997
Sales manager, excluding retail trade	s	263,999
Assess, control, local public administration	s	30,001
Construction inspector, public	s	21,000
Health administrators	s	100,003
Inspectors, excluding construction public	s	89,002
Officials, administrators, public	s	263,007
School administration, college	s	40,002
School administration, elementary, secondary	s	174,004
Office managers	s	288,007
Advertising agents, salesmen	s	63,501
Insurance agents, brokers, etc	s	412,007
Real estate agents, brokers	s	316,008
Stock and bond salesmen	s	101,802
Sales representatives:		
Manufacturing	s	393,992
Wholesale trade	s	634,991
Secretaries:		
Legal	s	104,004
Medical	s	79,003
Other	s	2,602,050
Stenographers	s	128,005
Typists	s	973,021
Bookkeeping, billing operators	s	68,504
Calculating machine operators	s	33,996
Computer, peripheral equipment	s	150,005
Duplicating machine operators	s	19,007
Keypunch operators	s	300,006
Tabulating machine operators	s	9,003
Other office machine operators	s	52,004
Bank tellers	s	287,007
Billing clerks	s	123,009
Bookkeepers	s	1,540,027
Cashiers	s	968,994
Clerical Assistant, social welfare	s	1,501
Clerical supervisors	s	192,005
Collectors, bill and account	s	60,002
Dispatcher, starter, vehicle	s	63,999
Enumerators and interviewers	s	65,002
Estimators, investigators	s	329,007
Expeditors, production controllers	s	199,995
File clerks	s	270,009
Insurance adjusters, examiners	s	105,002
Mail handler, executive post office	s	130,006
Messengers and office boys	s	56,004
Meter readers, utilities	s	36,999
Payroll, time keeping clerks	s	175,013
Real estate appraisers	s	24,001
Receptionists	s	423,019
Shipping, receiving clerks	s	437,991
Statistical clerks	s	291,006
Teachers aides, excluding monitors	s	150,004
Ticket station, express agents	s	94,001
Weighers	s	45,996
Sign painters and letters	i	20,001
Health record technology, technicians	s	12,300
Other managers, administrators	s	4,343,956
Auctioneers	s	5,499
Photographic process workers	i	68,999
Data processing machine repair	i	36,001
Office machine repairmen	i	64,499
Radio, television repairmen	i	137,002
Bookbinders	i	32,000
Compositors and typesetters	i	169,997
Electrotypers, stereotypers	i	7,000
Engravers, excluding photoengravers	i	9,297
Photoengravers, lithographers	i	33,500
Pressmen and plate printers	i	138,998
Pressmen apprentice	i	2,800
Printing apprentice, excluding pressmen	i	6,000
Telephone installers, repairmen	i	280,004
Telephone linemen, splicers	i	52,001
Motion picture projectionists	i	16,000

INDUSTRY SECTOR OCCUPATIONS

Carpenters	984,985
Carpenters apprentices	8,900
Brickmasons and stonemasons	171,997
Brick, stonemason apprentice	4,499

INFORMATION SECTOR OCCUPATIONS—Continued

Occupational type	Legend	1970 employment
Bulldozer operators		99,998
Cement and concrete finishers		64,999
Electricians		449,993
Electricians apprentice		21,300
Excavating, grading, machine operators		279,995
Floor layers, excluding tile setters		23,499
Painters, construction, maintenance		399,995
Painter apprentice		1,600
Paperhangers		10,000
Plasterers		28,000
Plasterer apprentice		500
Plumbers and pipefitters		354,995
Plumbers, pipefitters apprentice		14,000
Roofer and slaters		62,998
Structural metal craft		78,999
Tilesetters		31,999
Blacksmiths		9,999
Boilermakers		29,998
Heat treaters, annealers, etc		22,997
Forgemen and hammermen		17,999
Job and die setters, metal		99,997
Machinists		360,992
Machinist apprentice		9,998
Millwrights		80,997
Molders, metal		54,999
Molders apprentice		799
Pattern and model makers		41,996
Rollers and finishers, metal		23,000
Sheet metal workers, tinsmiths		154,996
Sheet metal apprentice		5,999
Tool, diemakers		167,996
Tool, diemaker apprentice		9,999
Air conditioning, heating, refrigeration		129,998
Aircrafts		119,999
Auto accessories installers		5,998
Auto body repairmen		158,997
Auto mechanics		836,985
Auto mechanics apprentice		2,599
Farm implement		46,300
Heavy equipment mechanics, including deisel		686,987
Household appliance mechanics		119,999
Loom fixers		18,000
Railroad, car shop repairmen		53,999
Mechanics excluding auto apprentice		7,007
Other mechanics and repairmen		224,004
Electric power linemen		100,002
Locomotive engineers		37,500
Locomotive firemen		18,000
Power station operators		17,301
Bakers		124,998
Cabinetmakers		74,996
Carpet installers		46,999
Cranemen, derrickmen, hoistmen		169,993
Decorators, window dressers		69,998
Dental laboratory technician		30,001
Furniture and wood finish		22,999
Furriers		2,599
Glaziers		24,999
Inspectors, log and lumber		17,000
Inspectors, other		128,002
Jewelers and watchmakers		41,498
Millers, grain, flour, feed		8,800
Piano, organ tuners, repairmen		7,000
Shipfitters		11,000
Shoe repairmen		30,998
Stationary engineers		178,006
Stone cutters, stone carvers		7,000
Tailors		67,997
Upholsterers		67,998
Craftsmen, kindred workers		79,997
Former Armed Forces members		500
Craft apprentices		10,698
Drill press operatives		75,998
Furnacemen, smeltermen, pourers		74,399
Grinding machine operatives		144,998
Heaters, metal		7,499
Lathe, milling machine operatives		154,997
Metal platers		35,999
Other precision machines operatives		76,499
Punch stamping press operatives		179,995
Solderers		42,399
Welders and flame cutters		537,992
Carding, lapping, combing		17,800
Knitters, Loopers, and toppers		34,599

INDUSTRY SECTOR OCCUPATIONS—Continued

Occupational type	Legend	1970 employment
Spinners, twisters, winders		149, 996
Weavers		45, 999
Other textile operatives		189, 994
Checkers, examiners, etc, manufacturing		689, 989
Graders and sorters, manufacturing		45, 298
Meat wrappers, retail trade		46, 500
Packer, excluding meat, produce		648, 984
Produce grader, packer		25, 400
Asbestos, insulation workers		27, 000
Assemblers		943, 982
Blasters and powdermen		7, 099
Bottling, canning operatives		59, 997
Chainmen, rodmen, surveying		11, 001
Clothing ironers and pressers		199, 998
Cutting operatives		238, 992
Dressmaker, seamstress		109, 998
Drillers, earth		57, 498
Dry wall installers, lathes		47, 000
Dyers		27, 998
Miscellaneous machine operatives		1, 306, 970
Operatives		1, 131, 381

SERVICE SECTOR OCCUPATIONS

Occupational type	Legend	1970 employment
Boatmen and canalmen		5, 999
Bus drivers		228, 999
Conductors, motormen, rail		8, 400
Delivery and routemen		816, 987
Fort lift, 2 motor operatives		280, 992
Motormen, mine, fact, logging		10, 000
Parking attendants		30, 500
Railroad brakemen		48, 999
Railroad switchmen		52, 999
Taxicab drivers, chauffeurs		150, 009
Truck drivers		1, 377, 976
Chambermaid, maid, exc priv		218, 505
Cleaners and charwomen		611, 016
Janitors and sextons		1, 163, 028
Bartenders		189, 004
Busboys		110, 003
Cooks, excluding private		821, 019
Dishwashers		207, 005
Food counter, fountain workers		282, 007
Waiters		1, 096, 023
Food workers, excluding private		389, 010
Dental assistants		100, 007
Health aides, except nursing		133, 004
Health trainees		19, 000
Lay midwives		801
Nurses aides, orderlies		834, 026
Practical nurses		370, 013
Airline stewardesses		34, 200
Atten, recreation, amusement		80, 002
Atten, personal service		61, 996
Baggage porters and bellhops		21, 000
Barbers		157, 998
Boarding, lodging housekeepers		9, 600
Bootblacks		3, 199
Child care workers		339, 009
Elevator operators		39, 001
Hairdressers, cosmetologists		479, 999
Housekeepers, excluding private		111, 003
Personal service apprentices		1, 000
School monitors		26, 501
Ushers, recreation, amusement		16, 300
Welfare service aides	*	18, 001
Crossing guard, bridgetenders		46, 001
Firemen, fire protection		181, 004
Guards and watchmen		386, 014
Marshals and constables		5, 900
Policemen and detectives		388, 011
Sheriffs and bailiffs		40, 001
Child care workers		517, 015
Cooks, private		36, 001
Housekeepers, private		107, 003
Laundresses, private		12, 000
Maids, servants, private		696, 020
Animal caretakers, excellent farm		71, 002
Carpenters, helpers		116, 998
Construction labor		804, 987
Fishermen and oystermen		33, 985
Freight, material handlers		747, 983

SERVICE SECTOR OCCUPATIONS--Continued

Occupational type	Legend	1970 employment
Garbage collectors		83, 993
Gardeners, groundkeeper, excellent farm		537, 019
Longshoremen and stevedores		55, 996
Lumbermen, woodchoppers		81, 996
Stock handlers		717, 997
Teamsters		6, 993
Vehicle washer, equipment cleaners		175, 997
Warehousemen		149, 007
Other laborers		590, 993
Chiropractors		16, 026
Dentists		94, 111
Dietitians	*	30, 001
Optometrists		18, 003
Pharmacists		128, 798
Physicians, M.D. osteopaths	*	289, 810
Podiatrists		7, 001
Registered nurses	*	680, 021
Therapists		81, 603
Veterinarians		22, 600
Other medical and health		1, 001
Clinical lab technologist, technician		130, 004
Dental hygienists		16, 001
Radiologic technologist technician	*	52, 002
Therapy assistants		3, 501
Other health technologist, technician		60, 003
Airplane pilots		49, 000
Air traffic controllers	*	25, 001
Embalmers		5, 000
Actors		10, 700
Athletes and kindred workers		55, 702
Dancers		6, 000
Designers	*	119, 997
Musicians and composers	*	105, 002
Painters and sculptors		105, 004
Funeral directors		39, 998
Officers, pilots, pursers, shippers	*	31, 997
Officials of lodges, unions		65, 002
Railroad conductors	*	39, 999
Restaurant, cafe, bar managers		463, 001
Demonstrators	*	54, 996
Hucksters and peddlers	*	209, 998
Opticians, lens grinder, polisher		27, 000
Agricultural, biological technician excluding health		36, 002
Chemical technicians	*	76, 998
Electrical, electronic technician	*	154, 002
Industrial engineering technician	*	20, 004
Mathematical technician	*	1, 001
Mechanical engineering technician	*	12, 002
Engineering, science technician	*	190, 008
Flight engineers		6, 000
Other technicians excluding health	*	37, 003
Coaches, physical education teachers	*	17, 000
Clergymen		228, 006
Religious, excluding clergymen		43, 001
Recreation workers		60, 002
Managers, superintendants, building		100, 002
Sales clerks, retail trade		2, 189, 973
Salesmen, retail trade	*	406, 993
Salesmen, service and construction	*	151, 195
Counter clerks, excluding food	*	308, 998
Stock clerks, storekeepers	*	495, 998
Miscellaneous clerical workers	*	1, 206, 525

AGRICULTURE SECTOR OCCUPATIONS

Farmers (owners and tenants)		1, 690, 003
Farm managers		33, 000
Farm foremen		31, 000
Farm laborers, wage workers		897, 013
Farm laborers, unpaid family		474, 001
Farm laborers, self-employed		4, 000
Farm management advisors	*	7, 002
Foresters, conservationists		43, 002

APPENDIX B

SUPPORTING DATA FOR FIGURE 1

FIGURE 1.—PROPORTION OF U.S. LABOR FORCE, IN 3 SECTORS

	Agriculture	Industry	Services
1860			
1900	0.35	0.36	0.29
1940			
1950	.12	.62	.26
1960	.06	.57	.37
1970			
1980	.01	.38	.60

SUPPORTING DATA FOR FIGURE 2

FIGURE 2.—PROPORTION OF U.S. LABOR FORCE, IN 4 SECTORS

	Information	Agriculture	Services	Industry
1860	0.05			
1900	.10	0.35	0.19	0.36
1940				
1950	.16	.12	.10	.62
1960	.27	.06	.10	.57
1970	.48			
1980	.51	.02	.09	.38

SUPPORTING DATA FOR FIGURE 3

FIGURE 3.—PROPORTION OF U.S. LABOR FORCE IN INFORMATION OCCUPATIONS

	Information	Noninformation
1860	0.05	0.95
1900	.10	.90
1910		
1920		
1930		
1940		
1950	.16	.84
1960	.27	.73
1970	.48	.52
1980	.51	.49

SUPPORTING DATA FOR FIGURE 4

FIGURE 4.—PROPORTION OF U.S. LABOR FORCE IN INFORMATION OCCUPATIONS

[High and low estimates, 1960–80]

	Information	Noninformation
1960:		
Low	0.21	0.79
High	.27	.73
1970:		
Low	.44	.55
High	.48	.52
1980:		
Low	.48	.52
High	.51	.49

STATEMENT OF GLEN W. BELDEN, PRESIDENT AND CHIEF EXECUTIVE OFFICER, COMPUTER AND COMMUNICATION SERVICES DIVISION, UNITED AIRLINES

I. UNITED AIRLINES—A MAJOR USER OF TELECOMMUNICATIONS

Telecommunications plays a major role in United Airlines' (United) capability to provide the public with safe, efficient and economical air travel. In 1974 United spent $16,350.000 on leased telecommunications, mostly with the common carriers. Approximately 500,000 miles of private leased equivalent voice circuits were required for voice data, video and facsimile systems.

II. TODAY'S PROBLEMS

Generally, telecommunications services obtained from common carriers is very good. It is not as good as it should or could be considering the advancements made in the state of the art of electronics. This is particularly so in the area of reliability. Today's problems, which have been referred to the common carriers many times, can be categorized as (1) reliability, (2) telephone usage management.

A. *Reliability*

As stated in the first paragraph, United makes extensive use of private leased telecommunication circuits (500,000 miles). It is with these services that most of the reliability problems occur.

1. Circuit outrages frequently occur. As an example, United's private telephone system contains a major tandem switching point at its Executive Offices located near Chicago, Illinois. The tandem switching point consist of 16 trunk groups for a total of 190 circuits. On an average, 3 circuit outages occur daily of which the carrier is not aware until advised by United. For this reason, the 190 circuits are continuously monitored by United using special equipment leased from the carrier. Restoration of service often takes hours and sometimes even days. Similar outages occur on United's extensive data networks.
2. It is not uncommon for a trouble or outage to recur many times over a period of months before it is corrected.
3. United has found the need to lease duplicate and/or alternately routed circuits to increase reliability on critical operational systems.
4. Major communications hubs such as airports are vulnerable to frequent outages.

Recommendations

The common carriers perform in an extraordinary way in restoring services after fires, floods, high winds, etc. The promptness with which service is restored is phenomenal. More of this kind of attention should be applied to the day-to-day operations. Here are some suggestions which United feels the carriers should implement.

1. Automatic circuit assurance testing so the carrier knows of the failure before the customer. Such testing should also verify that transmission parameters are within specification.

2. Better testing methods to isolate trouble and restore service promptly should be implemented so the customer is not required to spend valuable time assisting with the testing.

3. Automatic switching to alternate circuits when such are provided so that a minimum of service interruption occurs.

4. More thorough training for testing personnel.

B. Telephone Usage Management

Today the user of large telephone systems receives very little information from the common carrier on the usage of the service. Accordingly, the user does not have an effective means of identifying the activity on the system. Lack of this detail hampers adequate control of use and makes it difficult to verify billing.

1. The type of call detail represented by toll call and message unit charges is not available on private line telephone networks.

2. Add-on hardware can be leased or purchased from other vendors which will provide the user with complete information on all calls made on private line systems.

Recommendations

1. Common carriers shall make available complete telephone usage information as an integrated part of all telephone systems.

III. REGULATORY ENVIRONMENT

It is United's opinion that the FCC has done an excellent job of regulating the common carriers in telecommunication service. This has helped the common carriers to provide one of the finest telecommunication services in the world. However, it should and could be better, particularly in view of the rapid advancements made in the electronic and computer fields. These advancements should have been incorporated in telecommunication services much earlier than they have been. Changes in the regulatory authorities granted to the FCC may be required to insure that such advancements are implemented in the future. Here are United's views on the telecommunications regulatory environment.

A. Telecommunications is a vital resource to the public in general, as well as business and government. The nature of telecommunications is such that it should be an integrated service for use by all in interstate, intrastate and international communications. Since it should be integrated, it must be regulated. Where facilities are jointly utilized for both interstate and intrastate services, the FCC should have jurisdiction.

B. The recent actions taken by the FCC to permit increased competition, in United's opinion, have been beneficial to the country, the users and probably to the common carrier industry as well.

1. Carterfone Interconnect Decision

United supports the interconnect decision. Competition in terminal equipment has brought the technological improvements to the user much quicker than would have been otherwise. United has taken advantage of this decision by installing the Collins Radio Company's computer controlled telephone Call Distributing System in United's new Regional Reservations Office located at Rockleigh, N.J. A similar system has been ordered for United's new Seattle, Washington Regional Reservations Office to be installed in September, 1975.

a. Competition

It is United's opinion, however, that the common carriers are being restricted in competing in the terminal equipment field because they are required to file tariffs covering the terminals. The carriers should be allowed to offer terminal equipment on a non-tariff basis.

b. Interconnection Protective Devices

United concurs that there is a need to retain the integrity of the public telephone network. This can be achieved either by an interconnect protective device or by equipment type certification. If a device is required, it should be a very simple arrangement at minimum cost. Other vendors should also be allowed to provide the device as a part of their terminals.

C. SPECIALIZED COMMON CARRIER DECISION

United is concerned about the decision to permit competition in interstate telecommunication transmission. Currently, United is using the services of specialized common carriers mainly to gain experience with their services and to take advantage of the lower cost at the moment. However, if all carriers were allowed to compete on equal terms, it would seem questionable whether there would be a differential in rates among the carriers or in their services. With the exception of one switched digital data service, there has not been any real new type service offered to date. In the current situation there is duplication of radio facilities across the country and a dilution of available radio frequencies.

It is United's thought that a means must be found by the FCC to insure that technological advances for improving reliability, introducing innovations and reducing cost be implemented reasonably soon after the new developments have been proven. Competition in the transmission field is one way. Another way would be for the regulatory legislation to provide incentives for the carriers to introduce improvements sooner. Some measure of performance (reliability and quality) should be required as a part of such legislation.

It is United's hope that regulatory legislation will not inhibit the carriers from maintaining a sound growth and offering new services and techniques promptly.

D. DOMESTIC SATELLITES

United is enthused about the domestic satellite decision. Satellites offer a new and competitive form of transmission with great potential for improved reliability and quality at reduced costs.

E. SHARED USE SERVICES

The large telecommunication networks and computer systems operated by United give the potential for providing many services to users other than airlines. United would like to see the sharing provision liberalized and become more flexible.

STATEMENT OF C. RAYMOND KRAUS, PRESIDENT, CONSULTING COMMUNICATIONS ENGINEERS, INC., VILLANOVA, PENNSYLVANIA

1. QUALIFICATIONS

We are qualified to testify in the area of telecommunications research and development by reason of the fact that Consulting Communications Engineers, Inc. of Villanova, Pennsylvania is an organization of 180 outstanding telecommunications experts with 6,000 years of experience. It has accumulated much technical data on research and development in the last ten years. Our company has made studies evaluating switching systems in the U.S. and abroad, quality of service studies in 33 states comparing the quality provided by various switching systems, and has developed nad patented various systems and subsystems used in the telephone service and in related services. In the course of its studies, it has found out what the telephone user wants and urgently needs and is not getting. In summary, we know the technical situation but also know what the telephone user needs. Also, we have furnished technical services to the new communications carriers created by the FCC to "compete" with the telephone companies.

We are also unbiased in our consulting work. We recognize, of course, that the question of our bias may be brought to the committee's attention in view of the fact that the bulk of our personnel has a vast amount of Bell System experience. The answer to this is that:

(a) The Bell System is the only place where adequate depth of training and technical knowledge of the telephone business may be secured. There is no other place.

(b) Our personnel is largely technical and has not necessarily been involved in Bell System policies. It should be understood that high scientific and engineering competence have their own objectivity in the analysis of technical subjects. Our experts have been involved in and have knowledge of telephone systems throughout the world. This experience has demonstrated to us the preeminence of North American and, particularly, Bell superiority in hardware, service and in telephone operations.

2. LACK OF TECHNICAL COMPETENCE IN FCC AND LACK OF DESIRE TO SECURE REAL TECHNICAL COMPETENCE

The FCC, in regulating a telephone industry with $100 billion investment, has no technical knowledge of the telephone business. It relies for assistance on:

(a) Outside technical help who are paid by the FCC to express anti-telephone company views and opinions. These experts (?) are apparently in league with the "contrived" common carriers and interconnect companies who are agreed to take money away from the telephone companies and thus from the telephone user. The FCC does not even pretend to have any competence in the field of *local* telephone service where regulation has been left in the hands of the states. However, in the interests of aiding those entrepreneurs who see large profits in invading segments of the telephone field, the FCC has not hesitated to make interconnection rulings seriously affecting local telephone costs and service. The state commissions are helpless against these rulings except by direct appeal to Congress.

There is a need for an independent Congressional investigation in this whole field to review the results of FCC biases before it is too late. The state commissions should be heard and really independent experts thoroughly competent and experienced in the telephone field should be called upon. This is an area where we feel that we can be of considerable help.

(b) The Department of Justice lawyers, who previously have taken action against firms having the attributes of bigness and success in the non-monopolistic areas, have now decided to invade the regulated monopoly field. These lawyers' ideas are in direct conflict with the fundamental principles of monopolies first set down by John Stuart Mill. The FCC, because of its lack of expertise, does not feel competent to oppose the invasion of the regulated field by the Justice Department. Unfortunately, we must agree that it is not equipped to handle this problem.

(c) The liberal policy of the FCC which tends to make it favor the little guy against the giant. The entrepreneurs of the new interconnect and specialized and other common carriers have played upon this bias in their eagerness to obtain quick profits from business taken away from the telephone companies. The credence given to this sob story of the entrepreneurs indicates that the FCC is completely lacking in technical competence; otherwise, it would take a stand in preserving low cost, high grade telephone service for the average telephone user. The FCC's lack of knowledge of the telephone business makes it easy prey for the self-seeking entrepreneurs.

3. FCC ACTING BEFORE ANY DEFINITE STUDY HAS BEEN MADE OF EFFECT OF ITS POLICIES ON THE AVERAGE TELEPHONE USER

NARUC and the telephone companies proposals for delay, until the magnitude of detrimental economic and service effects of the action of the FCC on the telephone user have been adequately studied and weighed, have been brushed aside by the courts and the FCC, and the FCC has precipitously embarked on the interconnect course with no real knowledge of the problems. Apparently, pressure from the new interconnect companies, the new "contrived" common carriers and the lawyers in the Anti-trust Division of the Department of Justice, has been great enough for the FCC to override the fundamental rights of the U.S. citizens to receive good and inexpensive telephone service.

4. EFFECT OF FCC POLICY ON TELEPHONE USER

Our studies indicate that if the FCC policies persist:

(a) The cost of local telephone service will rise dramatically.
(b) Service to the average telephone user will deteriorate.

In support of this we introduce as Exhibit A our Testimony before the Committee on Communications of the National Association of

Regulatory Utility Commissioners. The effect on the telephone user in summary is shown on the following Table I which shows who benefits and who pays.

TABLE I.—FCC PLAYING THE REVERSE ROBIN HOOD ROLE

[Stealing from the average telephone user to benefit the rich]

Action by FCC	Who benefits	Who pays	Resultant service
Interconnect PBX's	Big business, interconnect companies, manufacturers.	The poor average telephone subscriber, the telephone stockholder.	Much poorer service.
Specialized, common carrier, microwave.	Big business, new common carriers.	do	Poorer service.
Satellite common carriers	Big business, satellite common carriers.	The poor average telephone user, the telephone stockholder.	Do.
International record common carrier competition.	No one benefits	Big business, small business, average citizen (rates could be reduced by 75 percent if competition were eliminated).	Poor.

5. LONG DISTANCE REVENUES SUPPORT LOCAL TELEPHONE COMPANIES WHEREAS THE CONTRIVED CARRIERS DO NOT

The low telephone rates in the country are in large part due to the support from the long distance telephone revenues. A substantial portion of the long distance revenues represent as much as 46% of the overall income of the local Independent Companies; in some cases the percentage is 55% or more. The new intercity carriers created by the FCC pay nothing, and if these carriers continue to siphon away millions of dollars, the support for the local rates will decrease to a relatively small percentage and the rates will increase substantially. If the new carriers are not abolished, they should pay the local telephone companies a substantial portion of their revenues to help support local rates. This is also true of the interconnect companies.

All of the new carriers utilize the most expensive and most unique portion of the telephone plant—the subscriber cables between the nearest central office and the user. It is our contention that the use of this telephone plant for competitive purposes is illegal, and confiscates the capital of the telephone stockholder.

6. TELEPHONE USERS' NEEDS NEGLECTED

As the result of our studies we are of the opinion that the telephone user wants and is perfectly willing to pay for:

(a) Fast service—much faster than he has today. (See Exhibit B)

(b) Sophisticated telephone services—custom calling, centrex, etc.

(c) A modern usage-sensitive rate structure with many options to meet community needs.

(d) A family of new one-way services to supplement the telephone and fill the existing void—a relatively enormous time gap between the telephone and the mail. (See Exhibits C & D)

(e) A pipeline to the world of data banks, automated libraries, computers, banking, shopping, etc.

Unfortunately, although the telephone represents almost 100% of our fast random-access communications requirements, there have been few studies made of customer needs. It is particularly relevant that neither the Federal Government nor the regulatory agencies have made any effective attempts to study the real communications needs of the public. It is assumed that somehow the final result will be satisfactory to the unknowing public.

This is not true, and the technology gap between the capabilities of the modern computer and the telephone switching equipment is growing wider daily.

A basic communications need is *the exploration in depth of the communications requirements of the individual as part of the general public.* There have been many marketing studies made for specialized services but, as is customary, the general public's overall needs have been neglected in contrast to those of big business. It is essential to assess the total potential in terms of a variety of types of systems, each of which would perform differently relative to information delivery. The potential should be quantified in terms of the time of delivery desired, the relative urgency, the quantity of information to be sent, the necessity for an interchange of information, accuracy of information delivery, need for verification, etc. The question is: Can the regulatory bodies, particularly FCC, continue to operate satisfactory on a "seat of the pants" basis? We recommend an indepth study of the needs of the telephone user.

7. RESEARCH AND DEVELOPMENT—COMMUNICATIONS AS A SUBSTITUTE FOR TRANSPORTATION

There has been inadequate research and development work done on looking ahead for communications as a substitute for travel. The advocates of CATV insist that the future should be a nation wired for CATV. This would cost $100 billion and may be the wrong answer. On the other hand, little study work has been done to consider modernizing the telephone and bringing it into the electronic age. Its potential for all sorts of various services is almost completely unexplored.

8. ANTITRUST AND FCC PICKING ON THE WRONG TARGET

The Bell System, the prime target, is without doubt the foremost example of a modern corporation. It is not without fault and we are opposing it in certain matters. Nevertheless, it has done more for mankind than any corporation since modern civilization began. It leads the world in communications research and development by a big margin, its service is superior to the Independent telephone companies and its rates are lower. In rates, Bell's are 50% lower than in any developed country and also less than in the Independent companies' areas.

Over fifty percent of the area of United States has Independent Telephone Company service. We have measured it—this is our business—and it is more expensive, and the service is poorer in general. The products of the Independent manufacturers in switching are 5 to 10 years behind that of Bell. In transmission and telephone equipment they copy Bell. Bell's cost of manufacture are 20 to 40% less expensive than the Independents and the quality of Independents manufacture has been found to be poorer. We have made surveys in 33 states and almost invariably the business in Indepenudent areas tells us—"We wish we had Bell services".

With this outstanding performance by Bell, we are at a loss to understand why the Antitrust launched an attack on Bell except for their bias against bigness, as covered above.

CONCLUSIONS

The FCC in its technical ignorance, its automatic anti-big telephone company bias, and swayed by the Antitrust Division lawyers and the cries of the greedy entrepreneurs for wealth, has acted against the interests of the poor telephone user. First, we suggest that only legislative action can stop this economic nonsense. These extremely wasteful economic experiments must be terminated.

Second, we call for action on behalf of the average citizen, the telephone user, in the technical and service matters relating to communications. The telephone companies should be assisted to make rapid progress toward complete modernization of the telephone system rather than being oppressed by regulators and Justice Department lawyers who lack technical knowhow. The telephone is the life blood of our nation and its importance in our technological society is not understood by the FCC. Furthermore, the potential of telephone for a fast modern telephone service supplemented by a myriad of urgently needed services can be described only as fantastic.

Third, we strongly urge that funds should be made available to explore the communications needs of the average citizen. The regulators operate on a "seat of the pants" basis. The public is being denied adequate progress toward:

(1) Fast, modern telephone service with modern rate structures, much faster and better than our present service.

(2) Sophisticated services, custom calling, speed dialing, etc.

(3) A whole family of new one-way servics to fill the time gap between the mail and the telephone. The absence of these services is costing the public hundreds of millions of dollars.

(4) The telephone user pipe line to the world of data banks, automatic libraries, computers, banking, shopping, etc.

(5) The telephone as a substitute for transportation. It is not equipped today to do the job. This could be a means for conserving a large amount of energy.

We should be pleased to provide additional information to testify or to answer any questions.

FACTORS AFFECTING THE DEVELOPMENT OF TELECOMMUNICATIONS TECHNOLOGY

(By Jack M. Niles, Director, Interdisciplinary Program Development, University of Southern California to the Subcommittee on Communications, Committee on Interstate and Foreign Commerce, U.S. House of Representatives)

Mr. Chairman, it is a pleasure to offer some comments on the interrelationships between federal policy and the growth of telecommunications in the United States. I would like particularly to address my comments to an area of telecommunications development that is only partially and often indirectly covered by federal policy, but in which federal policy can have a profound influence. This is the area of business telecommunications, including the uses of telecommunications to link computers and form extensive information networks, and its interrelationship with various federal policy issues.

The development of superb telecommunications technology has been a major influence in the ascendency of the United States to its preeminent international position in the last few decades. In addition to its pervasive influence on the internal development of the United States, telecommunications and related computer technologies, along with other high technology and agricultural products, have provided a major contribution to a positive international balance of trade. The question at hand is: How can the United States maintain or increase this component of our industrial base? How can the government help in developing telecommunications technologies and their applications?

In our research at the University of Southern California, we have been investigating one particular application of telecommunications and computer technologies, namely, their use as an alternative to transportation. We have been examining the practicability of decentralizing business and governmental organizations through the combined use of telecommunications and computer technologies. In particular, we have been seeing whether, and how well, these technologies can:

(a) Reduce the distance workers commute to work, by developing networks of regional business offices interconnected by telecommunications (as opposed to the more typical single office location in urban central business districts), commuting distances of "information industry" workers could be significantly reduced,[1] permitting concommitant decreases in energy use and environmental pollution.

(b) Reduce inter-city travel. Our studies have shown that telecommunications and computer technologies can similarly reduce the need for inter-city business travel if the systems are properly designed.

(c) Improve worker productivity. With proper design of the interfaces between workers and the telecommunications-computer system, productivity can be substantially increased. As the technologies become more sophisticated, further increases in productivity can be expected.

(d) Improve delivery of government and municipal services. Our studies indicate that some common municipal services involving substantial amounts of information transfer, may be accomplished more effectively through the use of a dispersed telecommunications network.[2]

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[1] The "information industry" consists of organizations which transfer, store or manipulate information rather than produce physical goods or provide services. The "information industry" clearly encompasses both private and public (government) sectors of the economy. A typical member of the information industry consists of workers who commute to and from work in an urban central business district to feed data into or rather it from a computer, central files, or a similar storage and retrieval system.

[2] The studies to which I refer have been primarily sponsored by the National Science Foundation's Research Applied to National Needs (RANN) Program. The primary participants within the University of Southern California in this research have been the Annenberg School of Communications (which was the project leader for the study on improved delivery of municipal services), the Graduate School of Business Administration, the School of Engineering, and my own office of Interdisciplinary Program Development.

Throughout these studies, emphasis was placed on defining the primary communications problems of business and government organizations, thus evaluating the potential of various telecommunications and computer technologies for providing improved means of satisfying these communication needs. The first question that had to be answered in all cases was whether the use of telecommunications could provide economic incentives to various types of organizations to decentralize their operations. Our assumption was that the existence of an economic advantage through the use of telecommunications technology was a necessary, if not necessarily sufficient, condition for the increased use of these technologies.

Thus far, our research has met with positive conclusions: that is, we feel that in almost all cases we have studied, an increased use of telecommunications and computer technologies would have positive benefits in terms of reduced costs, or improved quality of output, or both.[3] Furthermore, it appears that most routine intra- and inter-organizational communication functions can be satisfied with the relatively narrow bandwidth telecommunications characteristic of a telephone system (although not necessarily using telephones). That is, while video communications such as those of interactive television systems, and to a lesser extent, systems such as AT&T's Picturephone ® seem to be psychologically reassuring for management level functions, they only appear to be necessary in a very small fraction of the total organizational communications volume. Thus, our research shows significant potential for development of computer-mediated telecommunications networks linking regional activity centers within major metropolitan areas and for interconnecting metropolitan areas throughout the United States. By extension, these links can be developed between the United States and other nations through the use of communications satellites. Furthermore, since the development of these networks is most likely to occur as the consequence of an increasing number of business and governmental organizations deciding to expand the uses of telecommunications to reduce operational costs or increase productivity, the demand for these technologies will constantly increase over the next few decades. This increase in demand will be essentially spontaneous since it will depend largely on individual organizational decisions influenced by market pressures, rather than government regulations, with some possible exceptions which I will discuss later.

With this research as background, I would like to discuss the following questions:

(1) Who are the primary interested parties in this potential evolutionary aspects of telecommunications?

(2) What influence can they have in accelerating or retarding the technological development of telecommunications?

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[3] Jack M. Nilles, Frederic R. Carlson, Paul Gray and Gerhard Hanneman, "Telecommunications-Transportation Tradeoffs" (Los Angeles: University of Southern California, 1974). Final report for NSF-supported research on the Development of Policy on the Telecommunications-Transportation Tradeoff (NSF-RA-5-74-020) under NSF Grant No. 39019. Gerhard J. Hanneman Herbert S. Dordick, "Implementing Two Urban Telecommunications Experiments Designed to Deliver Municipal Services" (Los Angeles: Univerity of Southern California, 1975).

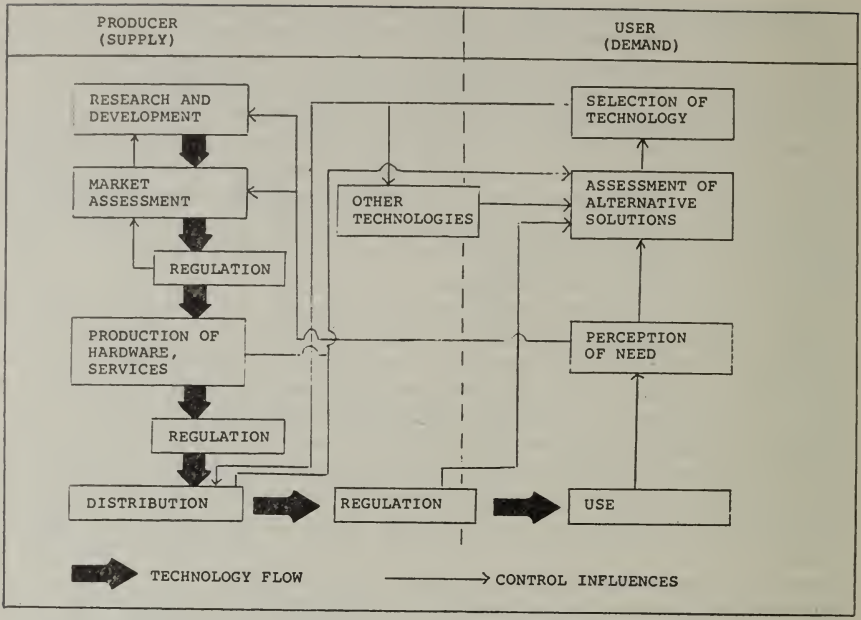

FIGURE 1: THE TELECOMMUNICATIONS TECHNOLOGY MARKET PROCESS

There are two main groups of interested parties: government and business. Both of these groups are involved in the telecommunications technology market process illustrated in Figure 1. Both government and business organizations can be found in most of the blocks depicted in Figure 1. Both government and business exert a regulatory influence on various aspects of the market process. Some of these influences are explicit while others are implicit. The influence of each of the blocks in Figure 1 on increasing or diminishing the development of telecommunications and related computer technologies will be discussed.

PERCEPTION OF NEED

Business telecommunications, until the last decade, were limited primarily to two-way telephone conversations and the use of the teletype system to transfer messages from point-to-point. In the last decade, however, increasing numbers of businesses have begun to use computer technologies to expand and diversify. Further, as techniques for inter-computer communications have developed (especially new applications of computer-time sharing operations) many business and government organizations are using telecommunications to gain access to computers they cannot justify owning or to provide more efficient use of their available computer capabilities. The enormous decreases in cost per information element in computers over the last decade have played a major part in the proliferation of computer technology. Microprocessor technology, which is now allowing the development of relatively inexpensive "smart" computer terminals, will continue this proliferation.

In the United States, the majority of medium-to-large business firms are members of the information industry. That is, they deal primarily with the internal and external transfer of information and information services. As organizations expand and their customer bases widen, they become more dependent on the rapid transfer of information from point-to-point. This applies to both private and public sector organizations. It is this need which is the driving force behind the telecommunications and associated computer technologies markets.

Our studies revealed further motivations for organizations to use the decentralization-enabling communications and computer technologies. One major motivation is the rising cost of operations in a congested central business district in a major urban area. In the case of one large company, we found that the availability of telecommunications and computer technologies allowed the company to disperse its operations to a number of locations around the Los Angeles area, while substantially reducing the cost of operations. In this case, the cost savings to the company came from a combination of higher productivity, the availability of a more qualified labor market, and greater job satisfaction among staff (therefore, a lower employee turnover rate). The communications functions of the organization were unaltered, but many of the functions which were formerly conducted on a face-to-face level in a central building may now be performed through the use of telecommunications and computer technology. Thus, telecommunications can serve as an alternative to the more traditional office techniques of conducting routine business operations. Telecommunications and computer technologies, moreover, appear to be at least as effective as the traditional mode of operations and permit more rapid organizational expansion.

ASSESSMENT OF ALTERNATIVE SOLUTIONS AND SELECTION OF TECHNOLOGY

There are several ways in which the business firm can satisfy its need for rapid point-to-point communications. Written messages can be sent via the U.S. Postal Service or by courier; representatives can meet face-to-face with customers or with other company representatives at distant locations; or, various forms of telecommunications can be utilized to transfer information. A primary consideration in the selection of one or more of these alternatives by an organizaiton is the cost of sending the information at a given level of effectiveness or accuracy. Decreasing costs of telecommunications and particularly the computer-mediated communications already mentioned, have motivated increasing numbers of organizations to opt for telecommunications solutions to their communications problems.

Another key factor in the assessment of alternative solutions to the communications need is the availability of various alternatives. Federal laws and other forms of regulation (such as a company's decision to withhold a new telecommunications product or service) can play an important part in this issue at several points. For example, if a telecommunications capability is not available to an organization at all the locations with which it wishes to communicate (at least at all the major points), it may choose another alternative, using transportation simply to ensure uniformity in its operations. Failure to establish an extensive, geographically dispersed service is one of the major reasons for the demise of Picturephone. On the other hand, government regulations which affect the availability of transportation (e.g., increasing fuel prices or, more importantly, direct restrictions on the availability of fuel) are causing many organizations to consider seriously the use of telecommunications, even where its use at first may be more difficult than the use of transportation. Thus, various aspects of the regulatory process are an important part of the technology selection process.

MARKET ASSESSMENT, RESEARCH AND DEVELOPMENT

In the supply sector of the market process, the first two areas to be affected by user demand are research and development (R & D) and market assessment. The interaction between these two portions of the supply process are, ideally, quite close. A potential producer of a telecommunications technology perceives a need in the demand sector and initiates appropriate research and development. Through the R & D process, which can be extremely short or quite extended, the supplier produces a prototype for a product which is hopefully saleable. There can be considerable government subsidy and regulatory interaction in this portion of the supply process. As the source of massive R & D funding and as a potential customer of telecommunications—computer technologies, the government has been a major force in the development of much of our national capability in these fields. A striking example has been the development of the ARPA network by the Department of Defense. The ARPANET is a unique and extraordinarily valuable testing ground for the development of computer interconnection techniques, teleconferencing, the "paperless" office, and related telecommunications and computer technologies. Some of the telecommunications techniques and technologies developed with ARPA support (e.g., packet switching) are now beginning to appear in the private sector.

Although ARPA, other Department of Defense agencies and NASA have been heavily involved in funding R & D for defense and space purposes, other federal agencies have not fully assumed the task of funding research related to the other areas I have been discussing. From our own experience, we have found that no federal agency, with the possible exception of the National Science Foundation, identifies itself as having a definite, central role in supporting research or coordinating the civil aspects of research in telecommunications and computer technologies. In fact, the Department of Transportation, which supported a small study in England two years ago on the substitutability of telecommunications for transportation, has apparently been suppressing the results of that research, presumably because it points out that the use of transportation is not necessarily the best alternative for all communications needs, including those which now normally use transportation as a means to this end. Those engaged in research on several aspects of telecommunications are familiar with the reply, from almost every federal agency, that while the research sounds interesting, it is not within the mission area of the agency being queried. Yet, because of the pervasive effects on society of these technologies, it is vital that some coherent programs be developed for exploring new uses and assessing the effects of these technologies.

Unfortunately, most businesses are unwilling or unable to take the enormous financial risks required to initiate the expensive research and development process associated with new technologies when a clear near-term market is not apparent. The possible exceptions to this general rule are AT & T, IBM, Xerox and other "giants" of the industry. These firms have two key attributes which enable them to engage in a high level (in the order of $2 to $3 billion annually) of research and development. One, they devote a reasonable portion of their income, typically in the order of five percent, to research and development. Two, they have a sufficiently high level of income to support diverse and innovative R & D programs. Their research programs have resulted in the continued growth of these companies, a subsequently greater share of the market, and finally, a high level of involvement in and interaction with the regulatory process. The extensive R & D activities of these "giants" has been instrumental in creating the massive and unmatched technological base for telecommunications in the United States; it also gives them a technological base for their own form of regulation: withholding the introduction of new products until the market or competition dictates their introduction.

In summary, federal subsidy and regulatory factors clearly have an influence not only on the quantity, but the type of research and development performed in the United States. Further, these regulatory factors are key elements in the assessment, by a potential technology producer, of those areas in which he is most likely to receive an adequate return on his R & D investment.

PRODUCTION AND DISTRIBUTION OF HARDWARE AND SOFTWARE

It is in the production, and particularly the distribution portions of the telecommunications technology market process, that regulatory factors are most evident. It is also in this area where the question as to who is regulating whom and to what end is most frequently the center of telecommunications policy discussions and litigations. One of the primary reasons for establishment of the Federal Communications Commission was to ensure that telecommunications technology and its products were made available to all sectors of the U.S. citizenry, whether or not the sales volume of hardware and services in a particular area justified the capital investment required to provide those services. It is argued that firms such as AT & T require both vertical and horizontal near-monopolies in order to provide a high level of service at a low cost to all its customers. The continuing provision of this high level of service includes a substantial technology research and development program, the fruits of which (e.g., the development of the transistor) often are useful far beyond the immediate interests of the corporation. The counter-argument is that the control of the market implicit in this arrangement allows the corporation to control (and presumably decrease) the rate at which new technology is diffused into the market. This latter argument has been the central theme of most of the regulatory litigation of the past several years with the FCC. Success of the counter-argument has led to the establishment of the specialized and value-added common carriers for data transmission and the demand that AT & T divest itself of Western Electric, its hardware manufacturing capability.

It is particularly this challenged area of data transmission which has the greatest potential impact on organizations considering substitution of telecommunications for transportation. Our study of a Los Angeles firm which employs 2,500 persons, indicated that the company could economically disperse its operations through the use of existing common carrier telecommunications facilities (mostly AT & T owned). However, the study also showed that the company could realize a substantial savings if it were to operate a private, wideband telecommunications network to interconnect its regional offices. Furthermore, the data transmission capabilities of the private network we considered were far greater than necessary for the company's operations. Thus, if a private telecommunications common carrier were to establish the same network interconnecting the designated regional points, and sell its capabilities to other firms who wished to disperse (thus distributing the costs), the savings to the individual company could be even greater.

Interestingly, this type of private network, since it would interconnect locations solely within the State of California (or, in other instances, within major metropolitan areas located solely in a single state), would not, apparently, come under the jurisdiction of the Federal Communications Commission. Instead, it would be under the jurisdiction of one or more state or local municipal franchise boards, most of whom are totally unequipped to deal with regulatory issues of this sort. Since no such specialized common carrier exists at present, the issue is hypothetical, at least for the present. The noteworthy conclusion, however, is that existing telecommunications technologies and services (both those currently available from AT & T, GTE, and other common carriers, as well as those available from specialized and value-added common carriers) combined with existing computer technologies, are sufficiently low in cost to induce businesses to adopt more extensive use of these technologies. As transportation costs increase, their attractiveness will increase even further.

While the major regulatory issues in this area have not appeared, they will include the following problems: Who will own and who will regulate (including setting quality and interconnect standards) the special purpose, metropolitan area interconnect networks? To what extent should this type of communications activity be left to private enterprise (in effect, confining the activity to the centers where the capital costs of installing the necessary transmission lines are sufficiently low)?

There is another aspect to be examined in the issue of free competition in the market versus restraining or guiding development. This relates to the efficiency of the R & D process. It is clear, from the success of the specialized common carriers, that suitable telecommunications capability can be attained by companies that do not possess the massive R & D capability of AT & T. It is clear also that the mortality rate of small, independent telecommunications technology and service producing companies is high. Another characteristic of small companies in the industry is that they perform very little R & D. Since their success is often due to the manufacture of products or the provision of services developed with government support or by larger firms, they frequently cease to exist when these larger resources are not available to them. Medium-to-large R & D performing firms in the industry may react to this situation by being increasingly protective about their innovations. If the smaller firm subsequently goes out of business, users of its products are thus faced with a sudden unavailability of goods and services. This potentially chaotic situation is both inefficient and costly for the general community. The conclusion, therefore, is that some competition is healthy, but that unbridled competition may be destructive in the long term. Therefore, regulatory policy formulation in this area should be directed toward allowing relatively free competition in the provision of new technological capability (as long as new firms meet or exceed minimum performance standards) combined with requirements for at least a minimum level of economic and social responsibility on the part of firms in the industry, including a return of a minimum fraction of net income to R & D and product improvement.

Another aspect of the social responsibility issue defined by our research was the breadth of impact of new uses of telecommunications technologies. If telecommunications technologies begin to replace various existing uses of transportation, and to serve as the means by which greater urban decentralization might occur, there might be profound effects on the structure of the cities, distribution of the population within them, changes in social pressures, and in the relative magnitude of the communication and transportation components of our economy. Some of these changes may not be in the best long term interests of the general public, yet at present we do not have sufficient understanding of the cause and effect relationships between existing telecommunications and transportation technologies and societal changes to be able to predict accurately the effects of the kinds of changes I have discussed. Thus, extensive investigation (through such agencies as the Office of Technology Assessment and the National Science Foundation) and public discussion is in order to address the question of which increases in telecommunications and which decreases in transportation are in the best longterm interests of the American public. Fortunately, we are at the stage of development in the application of these technologies where a considerable amount of experimentation concerning their effectiveness in meeting many of these societal and economic pressures can be gained through the marketplace. It is in these areas that I feel we should encourage the development of telecommunications technologies through the competitive process. At the same time, we should maintain a vigiliant eye on the results of these various technological experiments to assess which do and which do not portend longterm benefits to the public. Where significant reductions in energy use, diminished use of scarce resources, and greater productivity can be achieved without correspondingly great social costs of one sort or another, we should develop regulatory processes to ensure that these technologies are made available to the broadest possible segment of the public.

Our processes of regulation of telecommunications should be anticipatory rather than reactive. We should plan for the development of telecommunications capabilities of increasing quality by whatever means are most likely to provide them. At present, such planning does not occur.

SUMMARY

In summary, I would like to emphasize the following points in relation to promoting the development of telecommunications and related computer technologies in the United States.

1. These technologies constitute a vital part of our national technological base and are a major portion of the positive component of our international balance of trade.

2. The demand for these technologies is accelerating as a result of:
   - (a) the growth of the information industry;
   - (b) increasing pressures for efficient communications;
   - (c) increasing pressures toward decentralization; and
   - (d) increasing costs and decreasing availability of energy, paper and transportation.
3. The supply of these technologies in the U.S. is influenced by:
   - (a) the level of federally supported R. & D. oriented toward nonmilitary and nonspace applications (low);
   - (b) the level of industrial R & D [possibly diminishing. R & D is often the first to go when the economy tightens up. Investment tax credits promote increased acquisition of capital equipment, not R & D];
   - (c) the perceived return on investment on the part of individual producers [generally increasing, but high uncertainty];
   - (d) the level and quality of competition in the industry [increasing in both level and quality];
   - (e) the amount and type of externally imposed regulation on quality, allocation and quantity of hardware, software, firmware and services [quite variable]; and
   - (f) importation from or exportation to abroad [Although the data transmission industry has not felt major effects from foreign products being imported into the U.S., many U.S. development products are available abroad and not in the U.S., often because of regulatory constraints.].
4. The Federal government can act to to encourage private sector technological development and innovation by:
   - (a) assigning clear and unequivocal responsibility and funds to this end to a federal agency;
   - (b) encouraging, through "appropriate" regulatory policy and practices (including purchase of hardware and service), competition in development and improvement of telecommunications goods and services [The term "appropriate" includes development of minimum performance and responsibility standards by knowledgeable experts]; and
   - (c) stimulating industrial R & D (as opposed to capital equipment acquisition) by tax incentives and/or regulatory practices.
5. The government should also act to institute long range, anticipatory planning processes to develop a public understanding of the social impacts of these technologies, and, where apprepirate, to devise further means for encouraging or discouraging various avenues of development.

Thank you, Mr. Chairman, for allowing me to offer my comments to the Subcommittee on Communications. You might be interested to note that these comments were prepared, edited and printed by means of a "hard copy" terminal linked by telecommunications (a phone line) to a computer.

THE FUTURE OF COMMUNICATIONS AND THE LAW

By Douglass Cater, Aspen Institute

One prophet has predicted that future communications will have an impact on American lifestyles as radical as that caused by the motor car earlier in the century. Let no one doubt the extent and severity of the impact on our nation's laws as well.

OUR COMMUNICATION ENVIRONMENT

From the distant perspective of Thomas Jefferson or, later, Theodore Roosevelt, technology has already drastically reshaped the way Americans communicate. Those two lawyers would surely be astounded at the time given over to conversing with instruments. At the office, the typical American devotes a large portion of the day to the telephone and dictating machine while the secretary runs a minor publishing enterprise with help of the duplicator. At home, the American family spends a third of all waking hours before the cathode ray tube. By the time children graduate from high school, it is estimated, they will spend more hours before the TV set than in the classroom—or, indeed, at any other pursuit except sleeping. Other media—newspapers, magazines, records, movies, books—make lesser claims. In the background, one other instrument of the media, the computer, helps determine the American's credit, taxes, lawful standing in the community, and even loyalty to our country.

Experts claim that this is only the beginning. According to Professor Edwin B. Parker of Stanford University, 1975 is a fateful year in the communication revolution. Starting from a small base in 1950, which had remained virtually unchanged during the first half of the century, we have reached "the cross-over point at which 50 percent of the U.S. labor force is engaged in information processing occupations." It marks a fourth stage of economic development: from Jefferson's agrarian society to Teddy Roosevelt's era of manufacturing dominance and still later the period when service occupations flourished. Now America becomes the Information Society. And the end may not be in sight. Because new communication technology is a parsimonious consumer of energy and raw material, Dr. Parker speculates that there could be continuing rapid growth in this area of enterprise even when enterprises with more gluttonous consumption habits are obliged to level off.

We get a second perspective by projecting ourselves a decade ahead—to 1984 and beyond. George Orwell foresaw a time when the communication environment would be used to enslave rather than to enlighten mankind. He called this the age of *Big Brother*. A different characterization—Multiple Output Telecommunication Home End Resources—provides a somewhat less ominous acronym for that which may exist in the future.

What will be the technical characteristics of Mother? She will offer many more channels—through microwave, satellite, cable, fiber optics—than the present broadcast spectrum provides and there will be greater capacity crammed within each channel. Mother will be life-sized and will present the illusion of three-dimensionality. She will be able to narrowcast to neighborhoods or other focused audiences. She will be "interactive", permitting us to talk back to our television sets by means of a digital device on the console. Record and replay equipment, already being marketed, will liberate us from the tyranny of the broadcast schedule. Computer hook-up and stop-frame control can bring the Library of Congress and other Gutenberg treasuries into our living room. Via the satellite, we can have world-wide programming in what the communication experts call "real time." Mother will be able to beam broadcasts from the People's Republic of China directly into the U.S. household, and vice versa. She can do this technologically, although she will certainly face political obstacles.

What are the prospects for this new technology and what will be its impact on the law? Already, of course, technology has spawned legal issues which help to nourish a sizable Communications Bar in our nation's capital. My purpose is to attempt to peer beyond the present patchwork quilt of law and regulation and sketch a broader typology of concerns for the long term: economic, political, social, planetary, and those of the citizen-consumer.

COMMUNICATIONS AS AN ECONOMIC GOOD

Clearly, the thrust of technology will be to move us from an economy of scarcity to one of abundance in telecommunications. The issue in determining how fast and how far we go in this direction is who pays? Corporate communication systems, whether IBM or the U.S. Postal Service, presumably base investments on estimates of cost effectiveness but when we turn to the economics of the mass media, more complex issues may be governing. The American consumer is accustomed to receiving his communications at a price heavily supported by indirect payment. Typically, the newspaper reader pays only a quarter of the cost of the product. Commercial broadcast viewers expect to receive the product without any direct cost. The lion's share of what Americans see and hear via the mass media is paid for by those who have something to sell. The media marketplace is dominated by the advertiser.

As a result, mass media economics are unlike those of any other commercial enterprise in America. (Agriculture perhaps comes closest with a pricing system heavily influenced by government subsidy.) This dependence on advertising revenue results in measurable constraints on the communication flow. Though it may be assumed that individual merchants rarely dictate editorial policy, the fact is that the amount of advertising in a newspaper determines the size of its "news hole"—the portion to be filled alongside the ads. Advertiser choice dictates how many newspapers will serve a community and how many UHF channels or FM frequencies will be claimed. Advertiser choice demonstrably plays a role in shaping the size—and the survival chances—of American periodicals.

We have tolerated this economic system because we believe it helps keep the media free from dependence on government and thus reinforces the First Amendment. Over time, advertising dominance has become enshrined in regulatory and judicial dogma. But the coming age of abundant telecommunications will test whether the advertiser can sustain this marketplace indefinitely. Already, stresses in the media marketplace have caused acute legal anxieties. Congress, proscribed by the Constitution from abridging freedom of the press, has nonetheless felt obliged to pass a law exempting "failing" newspapers from anti-trust prohibitions. The Newspaper Preservation Act purportedly seeks to prevent press monopoly in a community by sheltering press duopoly permitting two competitors to share the same printing press as well as common facilities and non-editorial services. This inevitably creates a barrier against other entrepreneurs seeking to publish in the community, for the law offers the third party no right to participate in the combine. Thus, while the advertising-revenue economy has brought a steady attrition in the number of daily newspapers—only three percent of American cities now have more than one daily publishing firm—the law has served to bolster entrenched ownership rather than to stimulate new competition.

For commercial broadcasting, the issue goes even more directly to the method of raising revenue. Proponents of pay TV—over the air and via cable—seek to build a marketplace in which the consumer pays directly for the channel or individual program of his choice. The commercial broadcaster claims this constitutes a threat to "free" (i.e. advertising-financed) television. Even as he fights government regulation of his own programing, he urges regulatory restrictions against pay programing. With Solomonic wisdom, the Federal Communications Commission rules which sports and what vintage Hollywood movies can be broadcast or cablecast for a fee.

It appears likely that the push of technology ultimately will wear down the resistance of the regulators. But no one can predict what mixture of new technologies will prevail. Broadcaster hostility toward the cable, for example, could result in a future system more heavily oriented toward satellite and microwave. But whatever the components of the system, a further fissioning of telecommunication channels is predictable.

Two economic concerns will be noteworthy:

The first is the fate of non-commercial communications. Already, public broadcasting has dramatically posed the problem of building a system that is politically insulated and economically viable. (Congress struggled in 1975 to enact legislation providing five-year partial federal funding.) There have been very few success stories among enterprises attempting to harness television for non-profit uses. The issue will grow more pressing as new technologies open up channels which may be claimed—and, in the case of cable, have been reserved—for education, health, and other social benefits.

The second concern goes to property rights. Because information is not precisely like other commodities, we have attempted by legal fiat to define how its value shall be determined. But xerography and the computer are raising massive challenges to existing law. Prospective system of distribution promise to stretch present legal concepts to the breaking point. We may need to take an entirely new approach to the economics of information. Or perhaps, some suggest, we must reconsider the older communal concept advanced by Thomas Jefferson when he wrote: "He who receives an idea from me, receives instructions himself without lessening mine; as he who lights his taper at mine, receives light without darkening me." Certainly we need to cut through the maze of restrictions—copyright, union, etc.—which serve to limit rather than extend the flow of information.

COMMUNICATIONS AND THE POLITICAL PROCESS

Information is power. Those who control its processing and transmission have become major power brokers in the information society. There appears to be emerging a new federalism in America whose subgovernments are organized by process—education, health, energy, armaments, environment, etc.—rather than by geographical division. Each subgovernment, in asserting its priorities, has its own system of coding information. Each strives to create its own picture of reality for the public at large. In this political process, the mass media's coding—"news"—imposes its own priorities on the information flow and constitutes a political force. Some believe that the shaping of the public image is the dominant political force today.

What will be the impact of the new communications on our politics? Trends are already evident. During the explosive Democratic Convention in 1968, all hell broke loose one evening in the area where the Wisconsin delegation was seated. Instantly, the TV cameras zoomed in and reporters rushed to the spot with walkie-talkies. The whole viewing nation knew immediately what was the cause of the trouble. Yet Speaker Carl Albert, who was presiding over the convention, did not know, and he was the one who had to decide what to do about it. In microcosm, one witnessesd how leadership can be hustled by the formidable communication system of television.

TV has nurtured widespread public illusions about recreating a Greek marketplace of direct democracy. The age of "interactive" communications could carry this further. When the citizen sees and hears and can respond to what he believes to be the actuality, why should he have to rely on intermediating institutions to make decisions for him? When the political leader can reach directly to his constituents without the help of political party, why should he not opt for the people's mandate rather than the party's? Recent Presidents and Presidential candidates have been notably affected by this line of reasoning. It exposes an ancient vulnerability of our republic in which so much lip service is paid to the notion that public opinion should rule in every detail. There is potential here for demagogy, anarchy or both.

To discover a way past the dangers must be the task of legal thinkers as well as communicators. We need to examine how the institutions of representative democracy can be bolstered within the new telecommunication environment.

Other dilemmas must be faced: Why, in an age of such abundant communications, has there been continuing decline in voter participation? On the basis of surveys, one political scientist, Michael Robinson, has concluded that the more dependent an individual becomes on TV as a source of news, the more likely he is to feel he cannot understand or affect the political process. Robinson speculates that TV, unlike newspapers, reaches many who are not motivated to seek information about public affairs and that these "inadvertent" audiences are alienated by what they see. Such a proposition needs to be probed more deeply. It runs contrary to reformist instinct which is to prescribe more public affairs programming on TV as a means of overcoming voter apathy.

COMMUNICATIONS AND THE SOCIAL ORDER

Two quite distinct traditions have governed the transmission of information in America. *News*, as beneficiary of the First Amendment, has been jealously protected from state control; *education*, on the other hand, has been supported and regulated by governmental authority. These two traditions may come into conflict in an age when telecommunications moves increasingly into territory combining newsroom and classroom.

The FCC and the Courts have struggled without notable success to define clearly the First Amendment freedom of present broadcasters. But what happens when an open university, nationwide, is created via satellite and cablecasting? Or when a television channel delivers the print-out of the evening newspaper? One step toward clarification may be to distinguish between operation of the channels and production of content. Public policy, it has been proposed, should place the new technologies in the tradition of common carriers.

Some argue that society should move much more aggressively to exploit communications for the public good. Pointing to migratory trends which by the end of this century will place half of America's population in five areas of urban sprawl, Dr. Peter Goldmark, former President of CBS Laboratories, believes that the efficacious use of the new technologies can provide incentive for families and businesses to quit huddling together and to spread themselves more evenly throughout our vast land. Such an enterprise would require laws and appropriations on a scale that would make the earlier venture of rural electrification appear miniscule. It would also test whether an economic and cultural community based on electronic imagery can serve as a satisfactory substitute for the present day metropolis.

The testing of the electronic image's effects on society will continue in other ways. The Surgeon General's Scientific Advisory Committee on Television and Social Behavior, after three years and considerable research, concluded that there was "preliminary and tentative" evidence of a causal relationship between TV violence and the aggressive child. Neither the Committee nor policy makers are very certain what society should do with this finding. Public debate over harmful social effects of our telecommunication environment will continue to pose delicate concerns and the law will have difficulty accommodating a citizenry aroused about what Mother is doing to her children. This promises to be an arena where the First Amendment is subject to repeated challenge and redefinition.

TRANSFORMING THE PLANET

Communications, we like to assert, enriches both the sender and the receiver. On planet earth, it has transformed human society from a discrete number of enclaves inside the biosphere, creating what Teilhard deChardin calls the *noosphere*—"the film of organized intelligence now linking myriad individuals in cooperative knowledge enterprises." According to this analysis, the new information environment serves to integrate the functions of the *sociospheres*, *econospheres*, and *technospheres*. It has established remarkable linkages. John McHale points out that "the inhabitant of any of the world's large cities—London, Tokyo, Paris, New York—is more likely to find himself 'at home' in any of them than in the rural parts of his own country."

Amid wars and other disruptions, there has been comparative stability in the agencies which rule and regulate these information-based networks. But strong tensions exist, erupting most recently in bitter disputes over governance of the direct broadcast satellite. The violence of this anticipatory debate over a technology not yet in existence reveals how deep is the unrest provoked by the existing patterns of information flow throughout the world. The widespread feeling is that this flow is predominantly one-way and that its packaging and priorities contribute to a new "information imperialism" whose purpose is to maintain the dominion of the haves over the have-nots. The slight marginal cost of distributing film and other information beyond our borders accounts, in part, for the flood of entertainment made-in-or-by-America reaching the most remote outlets on earth. A fear which unites almost every national leader except the American is that the satellite will bring that flood directly into the home.

This has raised serious issues of international law. By a series of votes, the United Nations and UNESCO have appeared willing to grant recipient nations the right to censor in advance programs transmitted via direct broadcast satellite. U.S. spokesmen have argued in vain that this runs athwart the principle of the free flow of information long governing radio communications. Even our European allies perceive a threat which outweighs this principle. Since there is not likely to be a clear-cut resolution of the clash of principle and perception, international councils will have to move by small steps to develop operating rules which do minimum violence to both.

The advance of technology is exposing other inequities. Compare, for example, the communication system of the U.N. with that of a giant multi-national corporation such as International Business Machines. According to an analysis in 1970, IBM's internal processing system (ITPS) is a computer-based, message switched network which handles a daily average of 4,000 trans-Atlantic, 10,000 intra-European and 40,000 North American messages. Ninety percent are delivered within ten minutes, priority messages within seconds, at an average cost of fifty cents for seventy words between New York and Paris. The U.N. handles only a fraction of that volume and a comparable message, New York-Geneva, costs $2.80. U.N. messages to distant crisis points can lag by hours and even days.

Despite the leap-frogging of satellite communications, this planet's *noosphere* still shows critical evidence of maldevelopment. World law dedicated to universal understanding will be obliged to strive for an information flow that is not only free but equitably shared and moving in many directions.

CONCERN FOR THE CITIZEN CONSUMER

One proposition seems almost a truism: for every potential benefit to the individual from the new communication technology there is a corresponding threat. Increased social services to the home—fire and police protection, automated meter reading, instant polling—can also bring damaging invasions of privacy. Computerized data banks to relieve the burden of organizing information for and about the citizen can at the same time diminish his chances of a fresh start with a clean slate. More channels for pornography and trash. Our communication future will be shaped by hard decisions about what is in the individual's as well as the community's interest. Our long held dogma of the unfettered marketplace of ideas is being challenged by a marketplace already fettered by restraints of law, regulation, and economics. We cannot rely on the working of an invisible hand to make optimal choices for us.

Neither the law nor other disciplines operate with adequate understanding of the deeper mysteries of communications. Our research, for example, has been preoccupied almost exclusively with the *transmitting* process. We need to know more about man's *receiving* mechanisms. What gets through? The editors of *Scientific American* report that man's visual system has more than a million channels capable of transmitting instantly 10^7 bits of information to the brain. Yet the brain has the capacity to receive only 27 bits of information per second. These are the raw statistics of communications within the human anatomy. Sir John Eccles, the Nobel Prize-winning physiologist, believes that the most important frontier of brain research involves the study of inhibition—man's capacity to censor stimuli in order to prevent overload. Sir John makes the comparison: "It's like sculpture. What you cut away from a block of stone produces the statute."

Our journalists and other communicators pledge fealty to the proposition that both the individual and society thrive by the transmission of a maximum flow of information. Our law courts and our social ethics make us swear to tell "the truth, the whole truth, and nothing but the truth." We only dimly grasp how in an all-enveloping communication environment man chisels his little statues of perceived truth.

How do we measure what the new environment is doing to the citizen-consumer? In 1938, E. B. White, the essayist, witnessed his first TV demonstration and wrote, "A door closing, heard over the air, a face contorted seen in a panel of light, these will emerge as the real and the true. And when we bang the door of our own cell or look into another's face, the impression will be of mere artifice."

Now, a third of a century later, comes Tony Schwartz to carry the speculation further. His insights have peculiar power because he created the ill-famed political commercial for the 1964 campaign which showed a child innocently picking daisy petals as a countdown for a hydrogen bomb blast. Though there was no mention of the presidential candidate against whom its message was aimed, it evoked an image so unnerving that its sponsors withdrew it after a single showing. Schwartz appears to know whereof he theorizes.

Gutenberg man, he writes in his book, *The Responsive Chord*, lived by a communication system requiring the laborious coding of thought into words and then the equally laborious decoding by the receiver—similar to the loading, shipping, and unloading of a railway freight car. Electronic man dispenses with this by communicating experience without the need of symbolic transformation. What the viewer's brain gets is a mosaic of myriad dots of light and vibrations of sound to be stored and recalled at high speed. Amid this electronic bombardment. Schwartz speculates, a barrier has been crossed akin to the supersonic sound barrier or, in his image, the 90-mile-an-hour barrier when, a motorcycle racer must turn *into* rather than *out with* a skid. "Similarly, in communicating at electronic speed, we no longer direct information into an audience, but try to evoke stored information out of them, in a patterned way."

The Gutenberg communicator—for the past 500 years patiently transmitting experience line by line, usually left to right, down the printed page—is no longer relevant according to Schwartz's analysis. TV man has become conditioned to a total communication environment, to constant *stimuli* which he shares with everyone else in society and to which he must respond instantly. Schwartz believes that the totality and instantaneousness of television, more than particular programs, contribute to violence in society.

His premises lead him to the shattering conclusion that "truth is a print ethic, not a standard for ethical behavior in electronic communication." We must now be concerned not with Gutenberg-based concepts of weighing content, but with examining "effects". "A whole new set of questions must be asked, and a whole new theory of communications must be formulated."

We need not agree completely with Schwartz to accept his concern with "effects". After five centuries of slowly-acquired sophistication in distinguishing the true from the false transmitted by Mr. Gutenberg's invention, we must now find ways of mastering television's non-linear logic.

It is difficult to link Schwartz's vision with the contemporary clashes over communications law bearing such piquant code names as Red Lion and Tornillo and Watergate. The two court cases, among others, reveal the terrible dilemma which the courts face of reconciling perspectives on the First Amendment: freedom of the press to make its own decisions versus a public claim of access to a media system grown increasingly large, corporate, and not always mindful of its responsiblities. Watergate, on the other hand, exposed the vulnerabilities of big media when the President's men attempt to summon the concerted powers of government—anti-trust and Internal Revenue as well as FCC licensing—to intimidate journalistic adversaries by threatening their corporate underpinnings. The effort to breathe First Amendment meaning into a media environment so vastly changed from the early days of the Republic has stirred deep anxiety in so thoughtful a jurist as David Bazelon and even prompted Senator William Proxmire to reverse his previous support for the Fairness Doctrine. There appears no clear-cut path through the present thicket.

What will be the future? Robert Jastrow, Director of the Goddard Institute of Space Studies, predicts, "In the long term, the new satellites will provide a nervous system for mankind, knitting the members of our species into a global society." He *foresees* a planetary social organism in which the individual becomes like a biological cell. "Just as a cell cannot migrate from, say, the brain to the liver, the freedom of the individual will tend to be restricted in the new society." He compares this fifth communication revolution—more radical even than the previous four revolutions of speech, writing, printing, and radio—to that change in the history of life several billion years ago when multicellular animals evolved out of more primitive organisms.

Before such an awesome prospect, those who share concerns of the law may feel a sense of futility: technology seems to be not merely driving but transforming mankind. As we face the communication future, our challenge will be to rise above the present preoccupation with adversary proceedings and narrow casebook approaches. The law has a high calling in times of great change. This is to build institutions, both public and private, which give meaning to our basic values. The brave new world of 1984 and beyond will demand a creativity and skill in social invention which was the genius of our founding fathers.

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